[From the JOURNAL OF THE BOMBAY NATURAL HIST. SOC., April 15, 1934.]

REPORT ON BURMESE FISHES COLLECTED BY LT-COL. R. W. BURTON FROM THE TRIBUTARY STREAMS OF THE MALI HKA RIVER OF THE MYITKYINA DISTRICT (UPPER BURMA).[1]

BY

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PART II.

(*With text-figures* 4 *to* 14).

(*Continued from page* 831, *volume* xxxvi).

FAMILY: HOMALOPTERIDAE.

Homaloptera rupicola (Prashad & Mukerji).

One specimen (36 mm.) from Phungin Hka: '*Nga Hpai*'.

In 1929 Prashad and Mukerji (45) established the genus *Chopraia* to accommodate a very remarkable form of Homalopterid fish, *Chopraia rupicola*, obtained from the rocky streams of Kamaing in the Myitkyina District in Upper Burma. Despite the form being closely related to the genus *Homaloptera*, the fish had to be given a separate generic position in view of certain distinctive features which, till the time of its discovery, had not been ascribed to the genus *Homaloptera*. In his preliminary observations on the classification of the Homalopterid fishes, Hora (36) recognised the genus *Chopraia* as valid and placed it in the sub-family Homalopterinae. Later, in his monographic revision of the Homalopterid fishes he (37) studied them in greater detail and defined the various generic and specific limits. His extensive studies of these fishes, including certain types preserved in different museums in England and in other countries, enabled him rightly to delimit the various genera and species. Of the genera of the family Homalopteridae *Homaloptera* embraces a vast majority of remarkable torrential fishes with similar or diverse adaptive modifications. Hora's collective survey of the whole group of these fishes justified his considerably extending the generic limit of *Homaloptera*; and *Chopraia* should now be considered a synonym of *Homaloptera* as emended by Hora.

The specimen under report agrees almost entirely with the specimens from the type-locality. The interorbital width is nearly equal to the diameter of the eyes. The pectoral fins reach the ventrals which are shorter than the former.

One important feature of *Homaloptera rupicola*, to which atten-

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[1] Mr. Mukerji's paper was published in two parts because of the need of keeping down the number of pages in the *Journal*. The author was unaware of this arrangement by the Editors; hence several citations to the bibliography which is published at the end of the present part were made in Part I and again references will be found in the present part to plates Nos. I-III which were published with Part I in volume xxxvi.—EDS.

tion has so far not been paid, is that the anterior portion of the ventral surface up to the base of the ventral fins is perfectly horizontal and this area is either devoid of scales or the scales are rudimentary. The flat and the naked ventral surface, the *Balitora*-like horizontal position of the pectoral fins, and the general facies of the fish clearly indicate that the fish is an inhabitant of the rapids. The occurrence of the species in the Phungin Hka seems to be rather unusual, and the specimen may have drifted into the river from some of the rocky streams which abound in the neighbourhood.

FAMILY: COBITIDAE.

Botia hymenophysa (Bleek.).

One specimen (100 mm.) from Sinan Hka: '*Nga-shaba*'.
One specimen (98 mm.) from Tang Hka: '*Nga-pasi*'.

Hora (26) has already discussed at some length the affinities of *Botia berdmorei* of Blyth with *B. hymenophysa* of Bleeker and has considered them conspecific. I have also gone into the question and after a thorough re-examination of the specimens of the two species preserved in the collection of the Indian Museum I agree that *B. berdmorei* is the same as *B. hymenophysa*. The species is extremely variable in regard to the colour pattern, the position of the anal opening and the different body proportions at different stages of its growth and in specimens from different localities.

The two well-preserved specimens from the Mali Hka system have more or less the same colouration as that of *B. berdmorei* figured by Day in his *Fishes of India*. There are from 11 to 12 broad vertical black bands along the sides which pass over the back and join the corresponding ones on the other side. Series of fine black specks and dots are arranged more or less longitudinally all over the body. The dorsal fin is variegated with black bands and blotches. The caudal fin is clouded all over with black dots; it is devoid of any band. A few blackish dots are present on the anal fin also. The rostral barbels are black.

Nemachilus botia (Ham. Buch.) *sensu stricto*.

(Pl. I, fig. 1; Pl. III, figs. 3 & 4).

Two specimens (102 and 73 mm.) from Tang Hka: '*Sumbrun*'.
Two specimens (88 and 85 mm.) from Tang Hka: '*Sumbrum Chang*'.
One specimen (81 mm.) from Tang Hka: '*Turelu*'.
One specimen (63 mm.) from Phungin Hka: '*Nga Kalang*'.

In his revision of the fishes of the genus *Nemachilus* from Burma, Hora (33) has rightly pointed out that "many of the species of the genus exhibit considerable individual variability"; and so far as I can judge, *N. botia* is perhaps one of the most variable species. It is due chiefly, if not entirely, to the extreme variability of the species that its precise limits have not so far been properly understood and defined, and this has been responsible for considerable misapprehensions. Specimens of *N. botia* have often been erroneously considered to represent a different and distinct species, while others of an allied but distinct species have been referred to *N. botia*. In this connection mention should be made of *N. nebulosa* (Blyth), the short history of which, given below, clearly shows how baffling at times may be the identity of *N. botia*.

In 1860, Blyth (3) described a new Cobitid fish from a single specimen obtained from Darjiling and presented by Dr. Wallich, under the denomination *Botia nebulosa*. He considered the form to be closely allied to "*B. grandis* but with face shorter (as described) and eight cirri not quite so strongly developed". Günther, apparently due to having no access to the type-specimen of *B. nebulosa*, which was deposited and is still preserved in the collection of the Indian Museum, did not include *B. nebulosa* in the synopsis of the various species of the genus *Botia* in his *Catalogue* (19); but he referred to the species in a foot-note (p. 366) without any comments. In 1869, Day (10) examined the type-specimen and published a short account of *B. nebulosa*. He remarked that "a bifid erectile (damaged) suborbital spine" is present. Later, in his *Monograph of the Indian Cyprinidae* he (11) included a short description of the loach without any fresh comments. Both in his *Fishes of India* and in the *Fauna* volume, Day retained the species *B. nebulosa*, and emphasized in a foot-note (p. 606) that the "suborbital spine was damaged in the unique example". The species did not receive further attention till 1922, when in his revision of the fishes of the genus *Botia*, Hora (26) remarked that "On examination I am unable to refer it (*Botia nebulosa*) to the genus *Botia*. I believe that it belongs to *Nemachilus* and in all probability is a male of *N. botius*". Hora gave sufficient reasons for considering *B. nebulosa* to be a *Nemachilus* and pointed out that Day's contention regarding the suborbital spine being damaged in the type-specimen was rather far-fetched, for, "the groove that is present is not sufficiently deep to justify the view that it ever contained a spine. The groove is of the nature of a shallow slit partly covered superiorly by a fold of skin. I have already remarked in a previous paper that such grooves and folds of skin form the secondary sexual characters of certain species of *Nemachilus*". Owing to the paucity of adequate material of *N. botia* for comparison, it was, however, not possible for Hora to go into further details about the systematic position of *B. nebulosa*.

I have thoroughly examined the five specimens under report from the Mali river system and compared them with the specimens of *N. botia* obtained from different places of India and Burma and referred to by Hora in his revision of the genus, and I find that my specimens are referrable to *N. botia*. Recently Messrs. G. E. Shaw and E. O. Shebbeare have collected abundant material of *N. botia* from various streams and rivers of Northern Bengal, and have presented a fine series of them to the Indian Museum. I have examined these specimens and after comparing the type-specimen of *Botia nebulosa* with all the specimens of *N. botia* now at my disposal, I am thoroughly convinced that *B. nebulosa* is not only not a *Botia* but it is an absolute synonym of *N. botia*, of which almost all the adult males are provided with a suborbital groove, and that the presence of a spine in the suborbital groove of the type-specimen of the former was purely conjectural on the part of the earlier authors.

It may not be out of place to mention in this connection that recently Deraniyagala (17) has reported the typical form of *N. botia*

under the name *Nemacheilus botia botia* (Ham. Buch.) "from several small streams" in Ceylon. From his description of the fish and the figure it appears that the Ceylonese fish is strikingly allied to *N. botia;* but the fact that the typical form of the species has not so far been known to occur anywhere in Peninsular India, much less in Ceylon, throws a doubt on the accuracy of the specific position of the Ceylonese loach. Moreover, it is quite conceivable that similar environmental conditions may tend to produce similar characters, and that the great resemblance between *N. botia* of India and the one of Ceylon may be due to a similarity in their environments. In the absence of any specimen of Ceylonese *N. botia* for comparative study, it is, however, impossible to judge its affinities. It may yet be pointed out that according to Deraniyagala the base of the dorsal fin of the Ceylonese *N. botia* is "as long as head or pectorals, which latter usually reach ventrals" (p. 38). In all the Indian and the Burmese specimens that I have examined, the base of the dorsal is certainly almost as long as the head or the pectorals, but the pectorals which are invariably shorter than the head hardly reach the ventrals.

From the foregoing account it is quite clear that a certain amount of confusion centres round the true identity of *N. botia.* The species, as it is understood in the present state of our knowledge, is widely distributed in the Indian and the Burmese waters. Below I have given, for future reference, a more or less detailed description of the species from materials from India and Burma. In view of the fact that no adequate figure of the loach has so far been published I take this opportunity to give figures from a well-preserved specimen from the Mali Hka system.

D. 3/11; A. 3/5; P. 1/11; V. 1/7; C. 18 (excluding the small compact outer rays).

The dorsal profile rises from the tip of the snout to the insertion of the dorsal fin with a sudden rise above the orbit. Behind the origin of the dorsal, the outline slopes down slowly, falls appreciably just beyond and below the end of the dorsal base, and then rises up again to the root of the caudal fin. The ventral profile is uniformly and faintly convex. The body is of rather stout build, spindle-shaped and compressed from side to side. It is thinnest at the caudal peduncle, which is squarish in shape and slightly higher than long. The greatest depth of the body is contained from 4.5 to about 5.2 times in the length of the body without the caudal fin. The head is moderate, its length being contained approximately from 4.2 to 4.5 times in the length of the body. It is slightly broader than high. The snout is prominent and somewhat blunt anteriorly. Its length is contained about 2.5 times in the length of the head. The eyes are rather large, placed high and nearer to the angle of the operculum than the tip of the snout. In some grown-up individuals they may be situated almost in the middle of the head. They are scarcely visible from the ventral surface. The orbital width is contained approximately from 3.8 to 5 times in the length of the head. The interorbital space is flat to faintly concave and is almost equal to or slightly narrower than

the diameter of the eyes. In front of and below the orbit on either side is a transverse subcutaneous ridge-like prominence. Usually there is no definite groove below the ridge, but in case of most adult male specimens a moderately deep groove is discernible. The nostrils are situated nearer the anterior margin of the orbit than the tip of the snout. The anterior ones are provided with well-developed tubular flaps. The mouth is sub-inferior, moderate and horse-shoe-shaped. The lips are rather fleshy and continuous at the angles of the mouth. The upper lip is provided with a few rows of small fleshy papillae, while the lower one has two rounded, raised cushion-like clusters of similar papillae situated centrally. The lower lip is interrupted in the middle. Both the lips are capable of being partly everted off from the jaws. The upper jaw is slightly longer than the lower and partly overhangs it. Both the jaws are provided with thin and sharp horny edges. The upper one is in the form of a small beak, while the lower one is shovel-shaped with a faint symphysial emargination to receive the upper jaw.[1] The gill openings are in the form of vertical slits extending below the insertions of the pectoral fins. There are two rostral and one maxillary pairs of barbels which are fairly well-developed. All the barbels are much longer than the orbital width.

Usually the insertion of the dorsal fin is much nearer the tip of the snout than the base of the caudal fin, but in some specimens, irrespective of age and locality, it may be situated almost in the middle of the same two points. It is long and in most cases longer than high. The length of its base is equal to that of the head or slightly shorter. Its outer margin is straight and oblique. The paired fins are inserted sub-horizontally. The pectorals are generally shorter than the head and are separated from the origin of the ventrals by a variable distance. The ventrals are situated almost vertically below the middle of the dorsal fin and are shorter than the pectorals. They are separated from the commencement of the anal by a considerable distance. The anal fin is short and when laid flat reaches the base of the caudal or just misses it. The pectorals, ventrals and the anal fins have rounded outer margins. The caudal fin is as long as, or a little longer or shorter than the head. It is longer than high, and faintly emarginate, with somewhat rounded lobes. The anal opening is variable in position, but in most cases it is situated almost midway between the tip of the ventrals and the origin of the anal fin.

The scales are of small to moderate size, conspicuous and imbricate. They are absent on the head and considerably reduced on the chest. The lateral line is generally complete, but in some cases it may be incomplete, not extending beyond the anal fin.

The colouration of the species is very variable, and not unlike most of the other loaches, it depends on the nature of the water

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[1] So far as I am aware, such characters of the jaws are found more pronounced in the fast stream-dwelling species of the genus *Nemachilus*. In such habitats as the fish feed almost entirely by scraping and rasping off algae and other organic matters from the rocky substratum, such modifications of the jaws are of the utmost utility.

and other environmental conditions. Ordinarily, the ground colour is pale olivaceous to yellowish orange with 12 to 16 blackish cross-bars of various turns and twists, descending a little below the level of the lateral line. These bands are generally uninterrupted in the young and half-grown specimens, while in adults they may be broken up into patches, scattered irregularly on the sides. A narrow dark band joins the tip of the snout and the anterior margin of the eyes. Another similar band is present dorsally between the eyes. A prominent black ocellus is usually to be found on the upper base of the caudal fin. All the barbels are dusky, excepting the maxillaries which are white. The fins are yellowish. The dorsal has 5 to 6 oblique, zigzag narrow blackish bands, while the caudal is provided with 5 to 7 posteriorly directed V-shaped dark bands.

in millimetres:

	Northern Bengal			Mali Hka System		
Length of body without caudal.	70·0	57·0	50·0	102·0	88·0	63·0
Height of body	15·0	12·5	10·0	18·0	18·0	12·0
Length of head	16·0	13·0	11·5	21·0	19·5	14·0
Breadth of head	11·0	9·0	7·0	18·0	13·0	10·5
Height of head	10·0	8·0	7·0	14·0	11·5	9·0
Length of snout	7·0	5·0	4·0	10·0	7·0	6·0
Diameter of eye	3·5	3·0	3·0	4·0	4·0	3 0
Interorbital width	3·0	3·0	2·0	4·5	3·5	3·0
Height of dorsal fin ...	15·5	13·0	12·0	19·0	18·5	12·0
Length of pectoral fin ...	15·0	12·0	11·0	18·0	16·0	11·5
Length of ventral fin ...	11·5	9·5	9·0	17·0	14·0	17·0
Length of anal fin	11·5	8·0	8·5	17·0	13·5	11·0
Length of caudal fin ...	16·0	13·0	11·0	22·0	18·5	13·0
Length of caudal peduncle ...	8·0	6·0	6·0	12·0	10·5	7·0
Least height of caudal peduncle	10·0	8·0	7·0	14·5	13·0	9·0

Nemachilus paucifasciatus Hora.

One specimen (51 mm.) from Phungin Hka: *'Nga Samwiyit'*.

In 1929, Hora (33) described this species from 15 specimens obtained by Dr. J. Coggin Brown from Hwe-gna-sang river in the Hsipaw State of the Northern Shan States. The single specimen collected from the tributary of the Mali river, which I assign to *N. paucifasciatus*, does not differ from the description and figure of the species excepting that the inner rostral barbels do not extend "as far as the nasal opening". They are much shorter, and the outer rostrals, instead of being extended to "below the middle of the eyes" reach only to the nasal opening.

Nemachilus multifasciatus Day *sensu lato*.

One specimen (50 mm.) from Phungin Hka: *'Sambrun'*.

In his *Fishes of India*, Day described this species from "Darjeeling and Assam"[1] and published an illustration of the fish from

[1] Dr. S. L. Hora kindly informs me that during his visit to Europe he had examined a specimen (No. '89.2.1.1669') in the collections of the British Museum (Nat. Hist.) which is labelled in Day's hand-writing as *Nemachilus multifasciatus*. The specimen was collected by Day from Assam.

a specimen from Darjiling (pl. cliii, fig. 7). In 1889, (53) reported the species from 'Meekalan' and 'Thagata Juva' near Moulmien in Burma. In his revision of the fishes of the genus *Nemachilus* from Burma, Hora (33) briefly observed that Vinciguerra's specimens from Burma have, in all probability been wrongly referred to *N. multifasciatus* and that the fish "appears to represent a new species". Unfortunately, the unique type-specimen of *N. multifasciatus* from Darjiling which is still preserved in the collection of the Indian Museum is in such a state of maceration that it has become useless for all taxonomic purposes. Moreover, the species seems to be so very rare that since Day's disocovery it has not been, leaving aside Vinciguerra's record from Burma, reported again from the Darjiling Himalayas or the adjoining areas, although fairly extensive collections of similar fishes have been made in these areas from time to time by parties of the Zoological Survey of India, and very recently by Messrs. G. E. Shaw and E. O. Shebbeare. Day's descriptions and figures of *Fishes of India*, in general, have been found to be so indefinite and inaccurate that it is often impossible to judge the precise limits of a species without having fresh specimens from the type-locality as a check. Under these circumstances nothing can be said definitely in regard to the specific limits of Day's *N. multifasciatus*, and the fish must be understood and shall remain provisionally known from whatever descriptive accounts it has to its credit until such time as the typical form is again obtained and definitely studied. It seems justifiable, therefore, to make reasonable allowance, so far as this fish is concerned, for minor differences in body proportions and colouration, etc., rather than to consider these as differentiating characters.

Sometime ago, Dr. D. Vinciguerra of the Genova Museum kindly presented a specimen of his Burmese *N. multifasciatus* to the Indian Museum. I have thoroughly examined the specimen and I am in agreement with Hora's view that the fish, judging it by Day's description of *N. multifasciatus*, appears to be new, differing from the latter chiefly in certain body proportions. But in view of what has already been said about the merit of Day's accounts and of the well-known plasticity of shape and structure under variable environmental conditions, of the stream-dwelling loaches in general, I do not propose to separate the Burmese *N. multifasciatus* from the one of India. As for the difference in colouration of the Burmese form, it is to be regarded as no more than a racial character, for, it is well known that most of the freshwater fishes of Burma have a characteristic brilliance of colouration.

In Colonel Burton's collections from the Mali Hka system there is a single specimen which is inseparable from Vinciguerra's specimen from 'Meekalan', although it differs somewhat in colouration.

Quite recently, Dr. H. M. Smith, of the Fisheries Department, Bangkok, Siam, collected several specimens of a species of *Nemachilus* from Northern Siam and sent a fine series to Dr. S. L. Hora for study and opinion. In forwarding the specimens Dr. Smith wrote that the fish "seems to be close to *multifasciatus*. It agrees in (1) very short barbels, (2) short pectorals,

(3) shape of caudal, (4) complete lateral line, (5) black bar at base of caudal and (6) general colouration, but (1) is more slender and (2) colouration of fins different". Having examined these Siamese specimens and after comparing them with Vinciguerra's form Dr. Hora informed Dr. Smith in a letter that the Siamese fish "is undoubtedly *N. multifasciatus* of Vinciguerra (but not of Day)" and that "Vinciguerra's *N. multifasciatus* appears to represent a new species", of which he already had a description written and an illustration made with a view to publish them under a new specific name.

I have also examined the same Siamese specimens, temporarily retained in the Indian Museum for study, and find that they are indistinguishable both from the 'Meekalan' specimen and the one from the Phungin Hka tributary of the Mali river under report and that all these specimens should be referred to one species. But as to whether they are referable to Day's *N. multifasciatus* or to a new species appears to be only a matter of opinion. In the present state of our knowledge of the fish in question, I am personally inclined to refer both the Burmese and the Siamese forms to *N. multifasciatus*. In case it is proved by future studies, based on adequate material, that the typical form of Day's *N. multifasciatus* is specifically distinct from the Burmese and the Siamese forms, the latter may be ranked as a separate species and the following description of the fish from the data before me as also the figure of the 'Meekalan' specimen to be published elsewhere by Dr. Hora will be of help in understanding the affinities of these fishes.

D. 3/8; A. 3/5; P. 1/11; V. 1/7; C. 19 (excluding small compact outer rays).

The profile in front of the dorsal fin is moderately arched, beyond which it is almost straight or a little sloping to the root of the caudal fin. The ventral profile is more or less horizontal or very slightly convex. The body is of a rather slender build, elongated and narrow. It is somewhat compressed from side to side, being thinnest at the posterior end of the caudal peduncle, which is squarish in shape and invariably as long as high. The utmost height of the body is contained from 5.5 to 6.5 times in the total length without the caudal fin. The head is short and a little broader than high; its length is contained from 4.8 to 5.2 times in the length of the body. The snout is moderate and pointed anteriorly. Its length is contained from 2.5 to 3 times in the length of the head. The eyes are small and situated almost in the middle of the distance between the tip of the snout and the angle of the operculum. They are not visible from the ventral surface. The orbital width is contained from 4 to 5.4 times in the length of the head. The interorbital space is usually slightly convex, but in certain adult specimens it may be almost flat. It is generally narrower than the diameter of the eyes. The nostrils are situated much nearer the anterior margin of the orbit than the tip of the snout. They are partitioned by a moderate and thin flap.

The mouth is sub-inferior, arched and of moderate size. The upper jaw is slightly longer than the lower one, and partly overhangs the latter. Both the jaws have sharp horny edges. The upper one is in the form of a small beak, while the lower is somewhat shovel-shaped with a symphysial emargination to receive the beak of the upper jaw. The upper lip is rather short and thin. The lower one is better developed and has faint longitudinal striations in the middle. The lips are continuous at the angles of the mouth. The upper one is capable of being partly everted off the jaw. The lower one is moderately united to the isthmus. The gill-openings are in the form of slightly curved slits, extending from the insertion of the lateral line to below the bases of the pectorals. There are three pairs of short barbels. The outer rostrals are slightly longer than the inner, but are almost equal to the maxillaries.

The dorsal fin is inserted midway between the tip of the snout and the base of the caudal fin or just a little nearer to the former. It is shorter than high, the length of its base being almost equal to the length of the head behind the nostrils; its height is slightly less than the depth of the body below it. The outer margin is straight or very slightly curved. The paired fins are placed sub-horizontally. The pectorals are generally shorter but in some specimens they may be equal to or even a little longer than the head. They are separated from the origin of the ventrals by a distance equalling about half their own length. The ventrals are situated vertically below or a little behind the origin of the dorsal. They are shorter than the pectorals and are separated from the commencement of the anal by a variable distance. They invariably reach as far as the anal opening, which is situated much nearer the origin of the anal than that of the ventrals. The outer margins of the paired fins are somewhat rounded. The anal fin is short and when laid flat it may almost reach the root of the caudal or may be separated from it by a short space. The caudal fin is usually longer than the head, but in some specimens it may be of equal length. It is longer than high and moderately emarginate with more or less equal and blunt lobes.

The scales are rather small and imbricate, but are not inconspicuous. They are more prominent on the posterior half of the body. The head and the chest are without scales. The lateral line is complete.

In regard to the colouration of *N. multifasciatus*, Day (14) observed that "vertical bands as wide as the ground colour pass from the back to the lower surface of the abdomen, *those between the head and the dorsal fin are numerous*, whilst there are about five posterior to it. *In some examples these anterior bands coalesce. A dark band at the base of the caudal* and dark marks on the head radiating from the eye. Fins yellow, the dorsal with four bands of spots and an equal number or more on the caudal. Ventral and anal with two bands each". (Italics are mine.). I find that the colouration of the Burmese and the Siamese specimens does not differ much from Day's description except for the number and the nature of the bands on the body and on the fins. In

most specimens the colouration of the different fins is lost in alcohol. In a couple of specimens from Siam, however, I find two distinct blackish bands on the dorsal and two on the caudal fin. Both the ventrals and the anal fins have a faint and narrow band. The characteristic dark band at the root of the caudal fin is present in all the specimens.

Remarks: From the present data it may be inferred that *N. multifasciatus* is more common in Burma and in Northern Siam than in the Eastern Himalayas, and that in all probability it is essentially a species of the Burmese and the Siamese waters, its range extending from these areas through Assam to the Darjiling Himalayas. Under normal circumstances, the density of population of a species of fish in any area is found to be inversely proportional to the distance between the centre of distribution and the area concerned. The extreme rarity of the species in the Eastern Himalayas and particularly in the neighbourhood of Darjiling, where fairly extensive collections have been made, seems to corroborate this view.

Measurements in millimetres.

	Meekalan		Northern Siam		
Length of body without caudal ...	52·0	50·0	66·0	48·0	36·0
Height of body	8·5	8·0	10·0	8·0	6·5
Length of head	10·0	10·0	13·5	10·0	7·5
Breadth of head	7·5	7·0	9·0	6·5	5·0
Height of head	6·0	5·5	7·0	5·0	4·0
Length of snout	4·0	4·0	4·5	4·0	2·5
Diameter of eye	2·5	2·0	2·5	2·0	1·5
Interorbital width	1·5	1·5	2·5	1·5	1·0
Height of dorsal fin	9·5	9·0	13·0	8·0	7·0
Length of pectoral fin ...	11·5	8·5	13·0	8·0	7·0
Length of ventral fin ...	10·0	8·0	11·5	8·0	6·0
Length of anal fin	18·0	17·0	10·5	17·5	6·0
Length of caudal fin	12·0	11·0	15·5	10·0	7·5
Length of caudal peduncle ...	6·0	7·0	9·5	7·0	4·5
Least height of caudal peduncle.	6·0	6·5	9·0	6·0	4·5

Nemachilus kangjupkhulensis Hora.

One specimen (48 mm.) from Tang Hka: '*Zaibru Htu*'.

The species was discovered by Hora (23) in 1921 from the hill-streams of the Manipur Valley where it is said to be "widely distributed". The single specimen from the Tang Hka tributary of the Mali river, which I assign to this species, does not appear to differ in any essential feature from the description of the fish given by Hora or from the type-specimen which I have examined. The colouration of the Burmese specimen is partly lost in alcohol, but it seems to correspond almost entirely to that of the Assamese individuals. The lateral line extends to the commencement of the ventral fins.

The species is recorded here for the first time from Burma.

FAMILY: CYPRINIDAE.

Genus: **Garra** Hamilton Buchanan.

When urging the revival of the oldest available generic names Jordan (39) pointed out that Hamilton Buchanan's *Garra* (1822) is a valid genus and it replaces *Discognathus* Heckel (1842). In his elaborate studies of the fishes of the genus *Garra*, Hora (24) discussed the matter in detail and stressed the validity of the genus *Garra* and pointed out its relationships with the allied genera. This removed the confusion that till then obscured the true status of the names *Garra* and *Discognathus;* and it was due entirely to this confusion that an indiscriminate use of both the names *Garra* and *Discognathus* found place in ichthyological literature. It is unfortunate, however, that some ichthyologists still uphold the name *Discognathus*, which despite its being more significant and suitable for the disc-mouthed fishes than *Garra*, has no nomenclatural status.

Bleeker (2) divided the genus *Garra* into two groups *viz.*, *Garra* and *Discognathus* according as the fish have four or two barbels. Subsequently, Garman (18) suggested a third group for such forms as *G. imberbis* Vinciguerra in which the barbels are absent. He called it *Ageneiogarra*. It appears to me far too artificial and quite unnecessary to split the genus *Garra* into three subgenera on the character of the barbels alone. It is a well known fact that barbels are very variable structures, specially among Cyprinoid fishes. Recently, Rendahl (49), however, has recognised these subgeneric divisions.

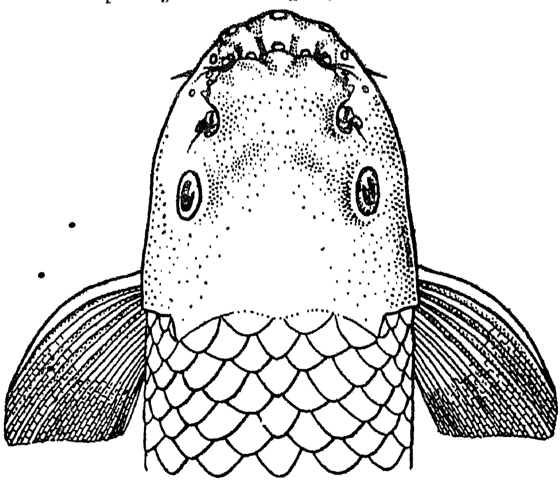
Garra lamta (Ham. Buch.) *sensu lato*.

One specimen (116 mm.) from Phungin Kha: '*Wuh tang*', 'Bulldog mouth'.

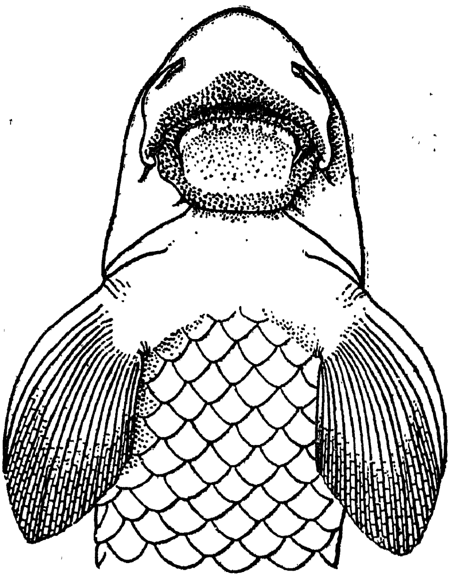
The proboscis is trilobed (Text-fig. 4). The central lobe is flat dorso-ventrally and occupies the greater portion of the snout. The

lateral lobes are small and are partly overhung by the central lobe A deep groove marks off the tip of the snout. The anterior portion of all the lobes and the tip of the snout are covered with sharp spiny tubercles. The eyes are dorso-lateral in position and are placed wholly in the posterior half of the head.

I have compared the specimen from the Phungin Hka with one of Vinciguerra's *G. lamta* (53) from 'Meekalan' in Burma and have found that the specimens agree in every detail except for the proboscis, which is bilobed in the Meekalan specimen.



Text-fig. 4.—Dorsal view of the anterior portion of the head and body of *Garra lamta* (Ham. Buch.) from the Mali Hka system showing the nature of the proboscis and the tubercles on the snout, ×1½.



Text-fig. 5.—Ventral view of the anterior portion of the head and body of *G. lamta* showing the nature of the mouth, the lips and the suctorial disc, ×1½.

Remarks: I provisionally refer the specimen under report to this species as it cannot be reconciled with any other known species of the genus found within the limits of the Indian Empire. Moreover, it has a closer affinity with *G. lamta* than with any other species. *G. lamta* has so far been considered as a composite form. When, however, Buchanan's (20) typical '*Cyprinus* (*Garra*) *lamta*' has been properly understood and defined this form as well as Vinciguerra's *G. lamta* from Meekalan may turn out to be a new species.

Crossochilus latius

(Ham. Buch.).

Two specimens (109 and 119 mm.) from Phungin Hka: '*Nga Lum*'.

The species was originally described by Hamilton

Buchanan in his *Gangetic Fishes* (20) from the "Tista" river at the base of the Darjiling Himalayas under the name '*Cyprinus latius*'. He placed the species in his 9th Division,—'*Cyprinus Garra*', because of certain morphological features and habits that the fish has in common with some species of *Garra*. That Buchanan was not far from the truth in considering *C. latius* a fish of the 'Garra kind'' is proved by the fact that later researches have led most authors tentatively to believe that *Garra* has evolved from a *Crossochilus*-like ancestor. It has been shown by Hora (24) that in certain species of *Garra*, at any rate, the structure of the air-bladder and the skeleton of the mouth-parts resemble those of *Crossochilus*.

Since the discovery of the species from Northern Bengal, the range of its distribution has been extended to "Nepaul and Assam" (11) and to "Sind, Orissa, N.-W. Provinces, Punjab, Deccan and along the Himalayas" (14). In 1890, the species was recorded for the first time from Burma by Vinciguerra (53).

After examining a large series of specimens of *C. latius* from different places of India and Burma, preserved in the collection of the Indian Museum, I indicated in an earlier paper (42) that "the species is very variable in respect of the shape of the head and the body and the lepidosis". But in the absence of any specimens from the type-locality it was not possible for me to go into greater details. Quite recently, however, Messrs. G. E. Shaw and E. O. Shebbeare have collected a fine series of *C. latius* from streams and rivers below Darjiling and have kindly presented several well-preserved specimens to the Indian Museum. Having examined these specimens, practically from the type-locality, I am more than ever convinced that it is necessary to draw a distinction between the group of individuals of *C. latius* found, on the one hand, along the Eastern Himalayas, *i.e.* in Northern Bengal, Assam and in Burma, and, on the other, those that are distributed in the Punjab and the N.-W. Provinces. Furthermore, the Assamese and the Burmese forms differ in certain noteworthy characters from the typical form. No specimens from Orissa, Sind and Deccan are available for examination at the present moment and it is, therefore, not possible to comment on them. Below I have given for future reference detailed descriptions of (i) the typical form of *C. latius* from Northern Bengal, (ii) the Assamese and the Burmese form and (iii) of the form from the Punjab.

Forma typica :

D. 3/8; A. 2/5; P. 1/13; V. 1/8; C. 18 (excluding the small compact outer rays); L. l. 37-42; L. tr. 10 ($5\frac{1}{2}/4\frac{1}{2}$).

The body is more or less elongate. The dorsal profile rises slowly from the tip of the snout to the point of insertion of the dorsal fin, beyond and behind which it gradually converges to the root of the caudal fin. The ventral outline is horizontal or slightly curved. The head is small, flat and compressed, and resembles that of *Garra*. It is considerably longer than broad and almost as broad as deep. Its length is contained from 5 to 5.2 times in

the length of the body without the caudal fin. The snout is very prominent, obtusely pointed, smooth, and overhanging the mouth. Its length is contained from 2.2 to 2.4 times in the length of the head. The eyes are fairly large and situated nearer the angle of the operculum than the tip of the snout. They are not easily visible from the ventral surface. The orbital width is contained from 3.6 to 3.7 times in the length of the head. The interorbital space is rather wide and convex and is much wider than the diameter of the eyes. The nostrils are situated nearer the anterior margin of the eyes than the tip of the snout. The gill-openings are moderate, extending from the anterior point of insertion of the lateral line to a short distance below the base of the pectorals. They are broadly attached to the isthmus.

The mouth is inferior and its opening is slightly arched. The upper lip is in the form of a fairly broad and crenulated fold overhanging the vestibulum of the mouth. Numerous round and soft papillae are arranged more or less regularly towards its free border. The lower lip forms a median, elevated and fleshy area slightly arched anteriorly. It is not separated from the isthmus and is covered at its anterior border with papillae similar to those of the upper lip. There is no distinct post-labial groove, and usually the lower lip is not connected with the upper.[1]

A pair of rostral barbels, which are usually shorter than the diameter of the eyes, are always present. For the most part they remain hidden inside a moderately deep lateral groove on either side of the snout. These lateral furrows may be indistinctly connected with the angles of the mouth.

The insertion of the dorsal fin is considerably nearer the tip of the snout than the base of the caudal fin. It is almost equidistant from the tip of the snout and the middle or the posterior edge of the base of the anal fin. It is higher than the maximum depth of the body and the length of its own base. Its last unbranched ray is weak, and the last branched ray is divided to the root. The outline is slightly concave. The pectoral fins are nearly as long as the head or a little longer. They are separated from the base of the ventrals by a distance equalling almost half their own length. When fully expanded they have a more or less rounded outer margin. The ventrals are slightly shorter than the pectorals, and are situated vertically below the 3rd or the 4th branched ray of the dorsal fin. They are separated from the commencement of the anal by a distance equalling about half their own length. The anal fin is short and is separated from the root of the caudal by a moderate distance. The caudal fin is strongly furcate, the upper lobe being usually longer than the lower. It is longer than the head and almost as long as high. The anal

[1] In a number of specimens from the streams of Manipur in Assam, 25 to 45 mm. long, I have observed that there is a well-defined post-labial groove and a distinct connection of the lower lip with the upper; and it seems highly probable that these characters become obliterated as the fish grows. Unfortunately, young specimens from Assam, as well as from other places, are not represented in a sufficient number in the collection of the Indian Museum for a detailed study.

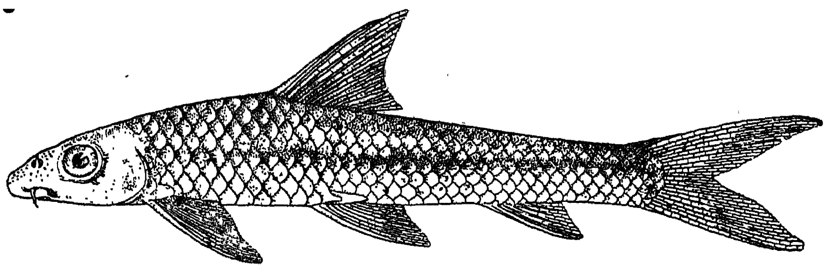
opening is variously situated. In most specimens the ventral fins extend considerably beyond it, while in others they just reach it.

The scales are of moderate size and arranged regularly. There are from 10 to 11 scales before the dorsal fin and usually from 18 to 19 round the caudal peduncle. The scales on the chest are considerably reduced in size, while those situated between the bases of the pelvic fins are somewhat enlarged. The lateral line is more or less straight and extends to the middle of the base of the caudal fin.

Colouration in alcohol is uniformly blackish above the insertion of the lateral line and whitish to faint orange below. The dorsal and the caudal fins are dusky. The other fins are almost colourless.

Assamese and Burmese form:

I have examined a large series of specimens from Assam collected by Dr. S. L. Hora from various streams in Manipur, and from Burma only three specimens, one from the Kyenchaung river in the Mergui District and two from the Phungin Hka in the Myitkyina District. So far as I can judge, the specimens from these two places do not differ in any essential characters from the typical form except in scalation and in the proportion of the



Text-fig. 6.—Lateral view of *Crossochilus latius* (Ham. Buch.) from the Mali Hka system, $\times \frac{3}{4}$.

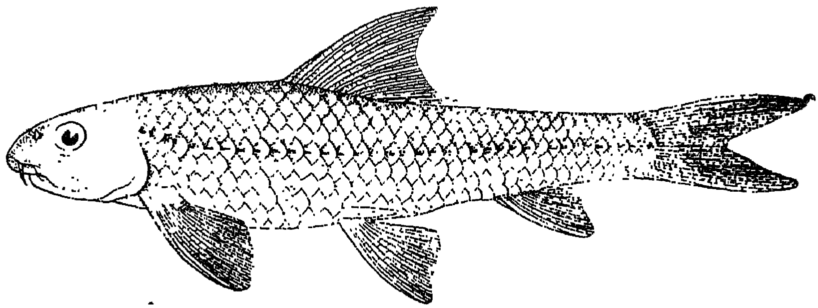
head in the length of the body. In most specimens from Assam and in all the three Burmese individuals I have counted only 8 scales ($4\frac{1}{2}/3\frac{1}{2}$) in a transverse series and from 15 to 16 round the caudal peduncle. In some of the Assamese individuals, however, there may be one more scale in a transverse row. In the typical form there are, as already mentioned above, 10 scales in a transverse series and from 18 to 19 round the caudal peduncle. The head of both the Assamese and the Burmese form is comparatively longer than that of the typical form. Its length is contained from 4.3 to 4.8 times in the length of the body without the caudal fin (*versus* 5 to 5.2 times).

These differences, however, in the number of scales and in the proportion of the head to the length of the body, do not, in my opinion warrant a claim of a separate taxonomic position for the Assamo-Burmese group of individuals of *C. latius*, and I am inclined to consider them no more than local variations.

Punjab form :

I have examined[1] a large series of specimens of *C. latius* from the Punjab collected by Drs. S. L. Hora and H. S. Pruthi from Katas Nallah, Salt Range and Khewra Gorge (about 2,000 ft. elevation), and as far as I can judge from the material before me, they seem to represent a distinct form from the typical *C. latius*. In my opinion the specimens from the Punjab, at any rate, should be kept as a separate subspecies until the chief differential characters noted below can be correlated with the ecological conditions in which the fish lives. For the subspecies I propose the name **punjabensis.**

C. latius punjabensis appears to be a dwarf form, the largest specimen at my disposal from the Salt Range is 136 mm. in length. On dissecting a number of female specimens from 30 to 45 mm. in length I have found ripe eggs. Unlike the typical form, the fish is stout and thick in build. The snout is rather blunt and broadly rounded anteriorly. It is not so prominent as in the typical form, and only slightly, if at all, overhangs the mouth. Its length is contained nearly 2.5 times in the length of the head. The length



Text-fig. 7.—Lateral view of *Crossochilus latius punjabensis*, subsp. nov., slightly reduced.

of the head is contained from 4.5 to about 5 times in the length of the body without the caudal fin. The eyes are comparatively small and their diameter is contained from 4.2 to 4.7 times in the length of the head (*versus* 3.6 to 3.7 times). The fold of the upper lip is relatively shorter and less crenulated, and so is the lower lip. The body is usually considerably deeper than the height of the dorsal fin (*versus* dorsal fin higher than the maximum depth of the body). The pectoral fins are usually shorter than the length of the head (*versus* equal to or slightly longer) and consequently, the distance between the tip of the pectorals and the insertion of the ventrals is much greater than half the length of the former.

[1] Since this report went to the press, the Zoological Survey of India received for determination a small collection of fish from Quetta from the Deputy Research Entomologist, Baluchistan. In the collection I found six specimens of different sizes, which correspond to the Punjab subspecies of *C. latius*. I am, therefore, inclined to think that the two specimens of '*Cirrhina latia* H.B.' reported by Zügmayer (*Die Fische von Balutschistan*, p. 24, Munchen, 1913) from Quetta and Kushdil Khan respectively, are also referable to *C. latius punjabensis*.

Measurements in millimetres:

	Northern Bengal.			Manipur, Assam.			Burma.			Salt Range, Punjab.		
Length of head without caudal	120·0	105·0	92·0	105·0	83·0	50·0	150·0	119·0	109·0	90·0	80·0	68·0
Height of body	25·0	24·0	20·0	23·0	18·0	10·0	35·0	23·0	21·0	24·0	18·0	17·0
Length of head	24·0	21·0	18·0	23·0	18·0	11·5	31·0	25·0	22·5	19·0	16·0	15·0
Breadth of head	15·5	15·0	12·0	15·0	11·0	7·5	21·0	16·0	15·5	15·0	13·0	11·0
Height of head	16·5	16·0	13·0	16·5	12·0	8·0	22·0	17·0	16·5	16·0	14·0	12·0
Length of snout	10·0	9·0	8·0	10·0	7·5	4·0	14·0	11·0	9·0	7·0	7·0	5·5
Diameter of eye	6·5	6·0	5·0	5·5	4·0	3·0	8·0	7·0	6·5	4·0	3·5	3·5
Interorbital width	8·0	8·0	6·0	8·5	6·0	3·5	11·0	9·0	6·0	8·0	7·0	6·0
Height of dorsal fin	31·0	28·0	23·0	25·0	19·0	12·0	36·0	30·0	29·0	20·0	20·0	17·0
Length of pectoral fin	24·0	22·0	18·0	19·0	16·0	10·0	30·0	22·5	21·0	18·0	18·0	15·0
Length of ventral fin	22·0	19·0	17·0	18·5	15·5	8·5	29·0	22·0	19·0	16·0	15·0	13·5
Length of anal fin	20·0	18·0	17·0	15·5	12·0	8·0	27·0	19·0	...	14·0	13·0	12·0
Length of caudal fin	28·0	28·0	24·0	23·0	20·0	13·0	44·0	28·5	...	24·5	20·5	19·0
Length of caudal peduncle	20·0	18·0	14·0	15·0	14·0	7·0	22·0	19·0	17·0	12·0	11·0	9·0
Least height of caudal peduncle	12·0	11·5	9·5	12·0	9·0	5·5	15·5	12·0	11·0	10·0	8·5	8·0

Labeo (Labeo) dyocheilus (McClell.).

(Pl. II, figs. 2 & 3; Pl. III, fig. 2).

One specimen (200 mm.) from Phungin Hka: '*Nga Lai*'.
One specimen (198 mm.) from Sinan Hka: '*Ulai*'.
One specimen (192 mm.) from Phungin Hka: '*Nga Jan*'.
One specimen (114 mm.) from Sinan Hka: '*Janri*'.
One specimen (42 mm.) from Phungin Hka: '*Ukhang*'.

In 1839, McClelland (41) described and figured the species under the name '*Cyprinus dyocheilus*' from "the clear active currents of the Bramaputra from Middle Assam to the rapids at the extremity of the valley". He further remarked that the fish "appears to be equally unknown (*sic*) in the mountain torrents and sluggish rivers and jeels of the plains". Unfortunately, both the description and the figure of the species given by McClelland are inadequate for determining the exact identity of the fish. Day, in his *Fishes of India* and *Fauna* volume gave rather a general account of the fish, but this and his figure (pl. cxxx, fig. 1) are inadequate for determining the species. According to him *L. dyocheilus* is distributed in the "Sind Hills and along the Himalayas to Sikkim and Assam" (14).

In the collection of the Indian Museum there are only three specimens labelled as *Labeo dyocheilus*, two of which were purchased from Dr. Francis Day, while the third one is a skin of a medium-sized specimen procured by Dr. S. W. Kemp from Yembung (1100 ft.) in the Abor Country in Assam (8). One of Day's specimens comes from Hardwar (No. 1522), and the other from Simla (No. 1533), and they are about 12.6 cm. and 32 cm. in length respectively. These two specimens from the Western Himalayas do not appear to me to represent the true *L. dyocheilus* so far as I am able to judge by comparison with the Abor specimen, which I consider to be the typical form of *L. dyocheilus*. It seems probable that the Western Himalayan form of the species is distinct from the one distributed along the Eastern Himalayas; but in the absence of adequate materials from both of these areas no definite decision on this point can be reached.

Recently, Messrs. G. E. Shaw and E. O. Shebbeare have collected a number of specimens from the rivers near Siliguri at the base of the Darjiling Himalayas and have presented a few of them to the Indian Museum. After a detailed study of all these specimens and comparing them with the Abor specimen, both Dr. S. L. Hora and I referred them to the typical form of *L. dyocheilus*.

In the collections of fishes from the Mali Hka system under report there are 5 well-preserved specimens, as detailed above.

These Burmese examples, although referable to *L. dyocheilus*, differ from it to some extent in lepidosis, colouration, etc.

During the preparation of the present account, a similar specimen has been received by Dr. Hora for determination and as donation to the Indian Museum from Dr. H. M. Smith of the Department of Fisheries, Bangkok, Siam. Dr. Smith remarked that the fish "came from the north-western Siam, from a stream at Meh Sord on the Burmese border. It is unlike anything else in our collection". The specimen has, however, been identified as *L. dyocheilus*, and it may be noted that this is the first record of the species from Siamese waters. On re-examination of this Siamese specimen I find that it corresponds entirely to the Burmese form and has the same differences from the Indian individuals. Thus it seems that *L. dyocheilus* is a very variable species, and according to its geographical distribution the species may be divided into the following main groups:

(i) Western Himalayan form.
(ii) Eastern Himalayan and Assamese form, *i.e. forma typica*.
(iii) Burmese and Siamese form.

From the foregoing data it is clear that it is not possible at the present moment to deal with the Western Himalayan form, while detailed accounts of the typical and the Burmo-Siamese form may be given for future reference. Below I have given a description of the *forma typica* of *L. dyocheilus* and the diagnostic features as also figures of the Burmese type.

Forma typica:

D. 3/12; A. 3/5; P. 1/17; V. 1/7; C. 19 (excluding the small compact outer rays); L. 1. 40-44; L. tr. 16-17 (9½-10½/6½-7½).

The head and the body are laterally flattened. The head is rather small and narrow, and covered with a thick integument. It is much longer than it is broad and deep, the length being contained about 4.5 times in the total length of the body without the caudal fin. It is considerably higher than broad, the breadth being almost equal to its length behind the anterior margin of the eyes. The snout is very prominent, muscular, and more or less pointed anteriorly. In some specimens, there is a distinct depression across it. A fairly deep lateral furrow is present on either side of the snout in all the specimens. The length of the snout is contained from 2.5 to about 3 times in the length of the head. It is provided all over with a series of fairly large open pores. A pendulous rostral fold is present. The eyes are rather small, have a free orbital margin, and are situated much nearer the angle of the operculum than the tip of the snout. The orbital width is contained from 4.5 to about 5 times in the length of the head,

and almost 2 times in the length of the snout. The interorbital space is wide and slightly convex. It is nearly twice as broad as the orbital width. The nostrils are situated much nearer to the anterior margin of the orbit than to the tip of the snout.

The mouth is horse-shoe-shaped and sub-inferior. Its opening is wide, the cleft extending nearly to the level of the anterior margin of the eyes. Both the lips are continuous and more or less fleshy. There is a distinct post-labial fold, deep-set in the post-labial groove. The upper lip is protrusible and it partly overhangs the vestibulum of the mouth. The lower lip is widely separated in the middle and reflected from the lower jaw. Internally, it is covered with series of stumpy papillae. A pair of maxillary bels, which are usually shorter than the diameter of the eyes, are situated at the angle of the post-labial fold. Both the jaws have an inner horny covering.

All the fins are well developed. The insertion of the dorsal fin is considerably nearer the tip of the snout than the base of the caudal fin. It is equidistant from the tip of the snout and the origin of the anal fin; in some cases it is much nearer the former. It is as high as or slightly less than the depth of the body below it. Its outer margin is concave. The pectorals are shorter than the head and are separated from the commencement of the ventrals by a distance equalling nearly half their own length. The ventral fins are slightly shorter than the pectorals and are separated from the insertion of the anal by a distance equalling almost half their own length. The anal fin is nearly as long as the ventrals, and when adpressed just reaches the base of the caudal fin or misses it by only a very short distance. It has a slightly concave margin. The caudal fin is much longer than the head and its own height. It is deeply furcate, the upper lobe in some grown-up specimens being slightly longer than the lower. All the rays of the dorsal, anal, pectoral and ventral fins have thin fleshy lateral lappets which are characteristic of most of the Cyprinoid fishes that inhabit the mountainous streams and rivers.

The scales are of moderate size and are arranged regularly on the body. There are from 40 to 44 scales along the lateral line and from 16 to 17 rows between the bases of the dorsal and the ventral fins. Between the base of the dorsal and the insertion of the lateral line there are from 9½ to 10½ rows, while between the lateral line and the base of the ventrals there are from 6½ to 7½ rows. The predorsal scales vary from 17 to 19. Around the caudal peduncle there are from 22 to 23 scales. The scales on the chest are considerably reduced in size. The bases of the dorsal, anal and the caudal fins are more or less scaly. The scaly appendages of the ventral fins are well-developed.

McClelland (41) has described the colouration of the fish as "bluish or brownish black above and on the extremities of the fins, but bluish-white along the belly; the sides are also bluish-white with various stains of red and yellow on the shoulder", while according to Day (14) it is "of a dull green, darkest above; fins darkest in the centre". It appears that both McClelland's and

Day's notes on colouration of *L. dyocheilus* were made on fresh specimens. In specimens, ordinarily treated and preserved in alcohol, the colouration is from a uniform reddish to greenish-brown above and paler below. There appears to be a faint blackish patch on the 4th and 5th scale of the lateral line.

Burmese and Siamese form:

In some of the Burmese and Siamese individuals of *Labeo dyocheilus* the head may be slightly shorter than that in the typical form, and the length of the head may be contained about 5 times in the length of the body without the caudal fin. The snout is rather bluntly rounded anteriorly. The depression across the snout is very well-marked. The dorsal fin is variable in height and may be as high as, slightly more or a little less than the depth of the body below it. The pectoral fins are usually shorter than the head; but it seems that in well-grown individuals they may be a little longer. In the Siamese individual from Meh Sord, which is 222 mm. without the caudal fin, the pectorals are longer than the head.

There are from 40 to 41 scales along the lateral line and 13 rows in a transverse series. Between the base of the dorsal fin and the insertion of the lateral line there are 7½ rows of scales, while between the lateral line and the base of the ventrals 5½ rows. Before the dorsal there are about 18 scales, while the scales round the caudal peduncle vary from 19 to 21.

The colouration in alcohol is dark brownish above and yellowish to white below. A fairly large faint blackish precaudal blotch seems to be characteristic of the Burmese and the Siamese forms. A narrow blackish patch on the 4th and the 5th scales of the lateral line is also to be found in some individuals. All the fins are dusky. The central rays of the caudal fin are blackish. In the Siamese specimen traces of fine series of dusky longitudinal lines are discernible on each side of the body. Each scale has a faint reddish dot in the centre.

Remarks: *Labeo dyocheilus* is a very variable and widely distributed species. It is known to occur in Northern Bengal, Assam, Burma, along the Eastern Himalayas and in north-western Siam. Day's specimens from Hardwar and Simla, mentioned above, do not seem to represent this species, but any conclusive remarks on the so-called *L. dyocheilus* of the Western Himalayas, are, however, impossible till adequate material from these areas becomes available for further study.

The species is said to be common in Assam; and is known by the local name '*Gorea*'. According to McClelland its "usual size is from one to two and a half feet in length, and though sometimes coarse, its flesh is always well flavoured". Colonel Burton has noted that in the Mali river system in Upper Burma the fish grows "upto 4 lbs."

Measurements in millimetres:

	North Bengal.	Mali Hka System.			Siam
Length of body without caudal ...	205·0	198·0	192·0	114·0	222·0
Height of body	55·0	56·0	49·0	31·0	62·0
Length of head	44·0	43·0	40·0	24·0	46·0
Breadth of head	27·5	26·0	21·0	15·0	28·0
Depth of head	34·5	34·0	29·5	19·0	39·0
Length of snout	16·0	15·0	14·0	8·5	17·0
Diameter of eye	9·0	8·5	7·5	5·5	9·0
Interorbital width	14·5	14·0	14·0	8·5	16·5
Height of dorsal fin	55·0	52·0	46·0	25·0	70·0
Length of pectoral fin ...	43·0	40·0	35·0	20·0	48·5
Length of ventral fin	41·0	37·0	32·5	19·5	45·0
Length of anal fin	41·0	36·5	35·0	19·0	47·0
Length of caudal fin	58·0	...	...	...	50·0
Length of caudal peduncle ...	38·0	38·0	35·0	23·0	45·0
Least height of caudal peduncle ...	27·0	24·5	23·5	13·5	28·5

Barbus compressus Day.

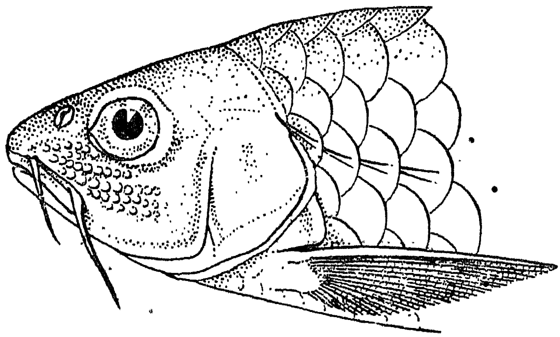
(Pl. I, Fig. 6).

One specimen (122 mm.) from Tang Hka: '*Urat*'.

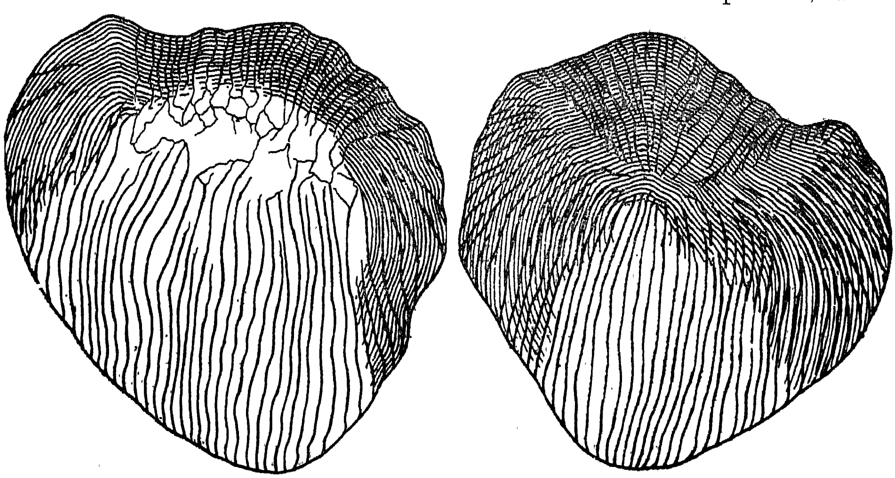
In 1869, Day (10) described the species from a single specimen, the precise locality of which was not known. He remarked: "The native country of the type-specimen is uncertain, but the fish was found in a bottle in the Calcutta Museum with an *Oreinus* from Cashmere. It is a fine specimen in excellent preservation". Unfortunately, since Day's discovery of the species further material was not available to clear up the doubt in regard to the *provenance* of this interesting fish and consequently little or no attention has been paid to the species. In the collection of the Indian Museum the unique type-specimen of *B. compressus* is preserved in the original bottle. The specimen has not undergone any marked

deterioration through preservation in alcohol for a period of sixty-four years, except for the colouration which is completely lost.

In the collection of fishes from the Mali Hka system there is a fine specimen which agrees in all essential characters with the type-specimen of *B. compressus* of Day, and I have not the least hesitation in assigning the fish to this species. In view of the fact that *B. compressus* stands rather on an inadequate description based on a single specimen and that the fish has not been figured so far, I take this opportunity to give a detailed description of the species based on a comparative study of both the type-specimen and the Mali river example and to publish an illustration of the latter. To facilitate comparison, a



Text-fig. 8.—Lateral view of the anterior portion of the head and body of the type-specimen of *Barbus compressus* Day showing the characters of the eyes, mouth, the lips and the barbels etc., ×1½.



a *b*

Text-fig. 9.—*a*. Scale from the base of the dorsal fin of the type-specimen of *Barbus compressus* Day, ×6.

b. Scale from the base of the dorsal fin of *Barbus compressus* Day from the Mali Hka system, ×6.

figure of the anterior portion of the type-specimen, showing the characters of the head and eyes, etc. is also added (Text-fig. 8). Characters of scales have often been considered to be of specific value among Cyprinoid fishes. I have, therefore, given camera lucida drawings of the scales of the two specimens under report.

The scales are taken from below the base of the dorsal fins (Text-fig. 9, *a* & *b*). It is clear from the structure of these scales that they are more or less similar except for some minor differences which are almost certainly due to a difference in the age of the two specimens.

D. 4/8; A. 3/5; P. 1/14; V. 2/8; C. 26 (excluding the small compact outer rays); L. 1. 25-26; L. tr. 7 ($4\frac{1}{2}/2\frac{1}{2}$)

The dorsal outline ascends gradually from the tip of the snout to the nape where it falls slightly and then rises up again to the origin of the dorsal fin. Beyond this point the outline slopes down rather abruptly and converges to the base of the caudal fin. The ventral outline is feebly convex throughout.

The head is conical, considerably compressed; and its length is contained nearly 4 times in the length of the body excluding the caudal fin. It is higher than wide, the maximum height being equal to the length of the head without the snout, while the width is equal to the length of the head behind the middle of the eyes. The snout is obtusely pointed and almost as long as the diameter of the eyes. The eyes are of moderate size and situated in advance of the middle of the head. Their diameter is contained nearly 4 times in the length of the head. The interorbital region is somewhat convex and its width is nearly equal to or slightly less than the diameter of the eyes. There are 5 to 6 transverse series of well developed conical tubercles on the anterior portion of the cheeks. On the snout there are no pores. The lips are thick and fleshy. The upper jaw is slightly longer than the lower one and is protrusible. Two pairs of barbels are present. The maxillary barbels are slightly longer than the diameter of the eyes. The rostrals are shorter than the maxillaries.

The dorsal fin is situated much nearer to the tip of the snout than to the base of the caudal fin. The insertion is vertically above the posterior margin of the 7th scale of the lateral line. The last undivided dorsal ray is fairly strong and smooth posteriorly. The height of the dorsal fin is as long as the head behind the opening of the nostrils. Its outer margin is slightly concave. The pectorals are as long as the head excluding the snout, and are separated from the insertion of the ventrals by a distance equalling about $\frac{1}{3}$ their own length. The ventrals are considerably shorter than the pectorals and are separated from the origin of the anal by $\frac{1}{2}$ their own length. The anal fin is rather short and extends to the middle of the caudal peduncle. Its outer margin is similar to that of the dorsal. The caudal fin is longer than high, the length being slightly more than the length of the head without the snout.

The scales are large and arranged regularly. There are 9 scales before the dorsal fin and 10-11 round the caudal peduncle. The bases of the dorsal and the caudal fins are scaly. The scaly appendages of the ventrals are fairly well developed.

The colouration of the type specimen has been described by Day as "silvery, fins stained darker". But, as already mentioned, the original colour of the specimen is totally lost. It is now

uniformly brownish with a faint golden sheen. The specimen from the Tang Hka is dusky all over the body above the lateral line and pale yellowish below. A fairly large black ocellus is present at the base of the caudal fin. Each scale is marked with a small dusky spot at the base. All the fins are dusky.

According to Colonel Burton's notes the fish is said to grow "up to 4 lbs.".

Remarks: From a careful examination and a thorough comparison of the two specimens under report I am convinced that the Burmese example is indistinguishable from the type-specimen of *B. compressus* Day. It is impossible, however, to come to any definite conclusion in regard to the type-locality and the distribution of the species even in the light of the present discovery of the species from Burma. For, on the one hand, its distribution may be sporadic in Kashmir and in Burma, while on the other, the fish may be an endemic Burmese form. Considering the very specialised nature of the fish-fauna of Kashmir, the former does not seem to me to be very probable, while in the event of the latter being true, which I am more inclined to believe, it is self-evident that, through inadvertence, the type specimen of *B. compressus* had been put in the same bottle with an *Oreinus* from Kashmir.

Measurements in millimetres:

	Type specimen	Burmese specimen
Length of body without caudal	155·0	122·0
Height of body	40·0	34·0
Length of head	38·0	31·0
Breadth of head	23·0	18·0
Height of head	27·5	22·0
Length of snout	11·5	10·0
Diameter of eye	10·0	8·5
Interorbital width	9·5	7·5
Height of dorsal fin	34·0	26·0
Height of last undivided dorsal ray	34·0	26·0
Length of anal fin	27·5	20·0
Length of pectoral fin	32·0	24·5
Length of ventral fin	26·0	18·5
Length of caudal fin	(Broken)	24·0
Length of caudal peduncle	30·0	20·0
Least height of caudal peduncle	18·5	13·3

Barbus tor (Ham. Buch.) *sensu lato.*

One specimen (190 mm.) from Phungin Hka: '*Shabyin Ningshaw*'.
One specimen (134 mm.) from Phungin Hka: '*Nga Kal*'.
One specimen (132 mm.) from Tang Hka: '*Shamyin Ningshaw*'.
One specimen (64 mm.) from Phungin Hka: *Hkauka La*'.

In a recent paper Deraniyagala (17) has revived the genus *Tor* Gray (1833) of which '*Cyprinus tor*' of Hamilton Buchanan is the type. In the *Genera of Fishes*, Jordan (39) remarked that *Tor* Gray "replaces *Labeobarbus* Bleeker" (p. 139), while about *Labeobarbus* Rüppell (1836) he opined that the genus is "probably not distinct from *Tor* Gray" (p. 186). In the absence of any definite data in regard to the specific limit of Buchanan's (20) *C. tor* which he obtained from the Mahananda River in Northern Bengal, I am unable to agree with Deraniyagala's contention about using the name *Tor* for the species in preference to *Barbus* of Cuvier (1817) of which, *Labeobarbus* and certain other so-called allied genera have by most authors been considered synonyms. In this connection Günther's (19) useful remarks may be quoted. He observed: "Many attempts have been made to divide the Barbels into generic groups, as may be seen from the synonymy. And, indeed, when we consider the great number of species, and the great apparent diversity between the first and the last of the series, a further division must appear to be highly desirable. Yet nothing would be more contrary to the idea of natural genera, the transition from one extreme species to the other being perfect; and those attempts at generic subdivisions prove that the naturalists who proposed them had only a partial acquaintance with the species. The size of the scales, the development of the third dorsal ray, the form of the snout (and consequently of the preorbital) are perfectly useless as generic characters, in consequence of the complete series of intermediate forms. The lips are subject to variation in the same species: thus, for instance, some specimens of *B. bynni* would belong to *Barbus*, others to *Labeobarbus*" (p. 84).

This remark applies equally truly in the case of the genus *Tor* and the species *B. tor*. It is a well-known fact that great confusion centres round the true systematic position of *B. tor*, which is due entirely to the extreme variability of certain differential characters that are ascribed to the species, *viz.*, the length of the head and its proportion to the length of the body, the shape and size of the snout, the nature of the lips, the mesial lobe and the lepidosis, etc. All these features have frequently been found to vary so much in *B. tor* that they almost entirely overlap the distinguishing characters of the so-called allied genera and of the related species. Under these circumstances, I am of opinion that it is futile to recognise the genus *Tor* for such fishes as are widely variable in those very characters on which the genus is based, and that *B. tor* should be regarded as a composite and variable species of *Barbus* until it is possible to understand and define properly the specific limits of Hamilton Buchanan's '*Cyprinus tor*'.

The specimens under report from the Mali Hka system have

the dorsal fin rays stained with black. Series of black marks are present in the centre and on the posterior edge of the scales. The pigmentation is more prominent in the upper half of the body than in the lower.

It has been noted in the field-notes of Colonel Burton that the species grows "up to 60 lbs." The fish, however, has been known in Burma to grow to a much larger size, weighing over 90 lbs.[1]

Barbus clavatus burtoni, subsp. nov.

(Pl. III, Fig. 1).

Three specimens (162, 130 and 110 mm.) from Phungin Hka: '*Nga Ju*'.
One specimen (83 mm.) from Tang Hka: '*Nga Ju Chang*'.
One specimen (80 mm.) from Sinan Hka: '*Nga Ju*'.
One specimen (74 mm.) from Tang Hka: '*Nga Ju Hpraw*'.

In 1921, Hora (23) discussed at some length the affinities of *Barbus clavatus* McClelland with its allies and published a description and a figure of the species from several fresh specimens collected by him from the Senapati stream near Kairong in the Naga Hills in Assam. *B. clavatus* has hitherto been found in rivers at the foot of the Sikkim mountains on the northern frontier of Bengal and in the Naga Hills in Assam. Among the fishes of the Mali river system of the Myitkyina District under report, there are 6 well-preserved specimens, as detailed above, which, though very closely related to *B. clavatus*, differ from it in certain characters by which they may be allotted to a separate group. Besides these specimens from the tributaries of the Mali Hka, I have also examined a similar, but much larger specimen (172 mm.) collected by Mr. A. Macdonald from Sahmaw in the Myitkyina District and sent by the Curator of the Bombay Natural History Society to Dr. S. L. Hora for study, in March, 1926. On referring the matter to Dr. Hora and looking through the correspondence, I gather that, from an examination of the specimen in question, Dr. Hora came to a provisional conclusion that it represented a new form from Burma. He also had drawings made of this unique specimen with a view to publish an illustrated account of the fish in the Bombay Natural History Society's Journal as soon as a few more specimens of this interesting fish were available from the same locality for testing the adequacy of the description. But no more examples were obtained and the Sahmaw-fish, therefore, remained undescribed. Having before me a fine series of the same fish in Colonel Burton's collections from the same district of the northern frontier of Burma, it is now possible to judge of the affinities of the fish and to publish its description with figures. I am in agreement with Dr. Hora's original views about the form being new to science and I refer the specimen from Sahmaw, as well as the ones from the Mali Hka system, to a new subspecies of *B. clavatus*. I have the greatest pleasure in associ-

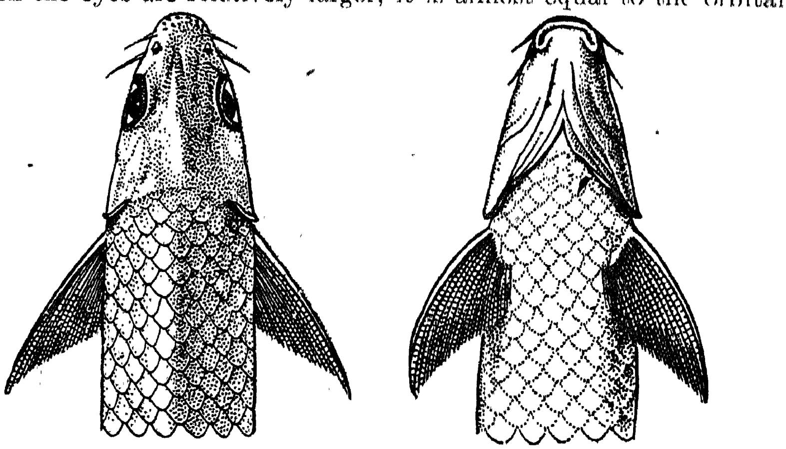
[1] Hertz, W. A., *Burma Gazetteer, Myitkyina District*, p. 17 (Rangoon, 1912).

ating the new form with the name of Lt.-Col. R. W. Burton. The fish may be characterised as follows:

D. 4/8; A. 3/6; P. 1/16; V. 1/8; C. 19 (excluding the small compact outer rays); L.1. 35-38; L. tr. 10. ($6\frac{1}{2}/3\frac{1}{2}$).

Barbus clavatus burtoni differs from the typical form chiefly in size, lepidosis, certain body proportions, colouration, etc. It seems to represent a much larger form than *B. clavatus*, as I find from an examination of the specimens of the latter form from the Senapati stream referred to above as well as two others collected by Dr. Murray Stuart from the Loglai and the Taron rivers in the Naga Hills. All these specimens from Assam are from 45 to 120 mm. in total length without the caudal fin, and some of them about 70 mm. in the minimum and 120 mm. in the maximum are gravid females, whereas the largest female specimen of *B. clavatus burtoni* from the Myitkyina District is 172 mm. long.

The head is short and conical and its length is contained from almost 4 to 5 times in the total length of the body without the caudal fin. It is proportionately longer in young specimens than in adults. The snout is obtusely pointed and is longer than the diameter of the eyes in adult individuals, while in young forms, in which the eyes are relatively larger, it is almost equal to the orbital



a b

g. 10.—*a*. Dorsal view of the anterior portion of the head and body of *Barbus clavatus burtoni*, subsp. nov., × *ca.* $\frac{2}{3}$.
b. Ventral view of the same, × *ca.* $\frac{2}{3}$.

width. Its length 3 to 3.3 times in the length of the head. 2 or 3 rows of horny tubercles, which are less p ced in immature stages. The eyes are fairly large and are nearer the tip of the snout than the free margin of the operculum. Their diameter is contained from 3.3 to about 4 times in the length of the head. The interorbital space is convex and greater than, or almost equal to the orbital width according as the fish is grown up or young.

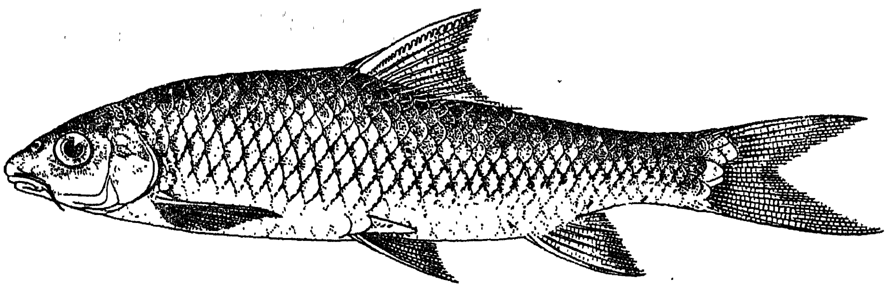
The mouth is horse-shoe-shaped and sub-inferior. The cleft of the mouth extends nearly to the level of the anterior margin

of the orbit. Both the lips are fleshy and continuous, the upper one partly overhanging the lower, which is widely interrupted in the middle. A fleshy pendulous rostral fold is present. There are two pairs of barbels, which are of nearly equal length. They are as long as the diameter of the eyes or slightly longer.

The dorsal fin is inserted almost in the middle of the distance between the tip of the snout and the base of the caudal fin, or slightly nearer the former than the latter. It is of considerable height, but its last osseous spine which is sharply denticulated posteriorly, is not so high as the depth of the body below it. Its outer margin is deeply concave. The pectorals are shorter than the head, but longer than the ventrals. The anal fin is rather short and has more or less a straight outer margin. The caudal fin is deeply forked and usually longer than the head and its own height. In some grown-up specimens the upper lobe is a little longer than the lower. The caudal peduncle is considerably longer than high, specially in adult individuals.

The scales are fairly large and arranged regularly. There are from 35 to 38 scales along the lateral line, and 10 rows between the bases of the dorsal and the ventral fins. Between the base of the dorsal and the lateral line there are 6½ scales, while 3½ between the lateral line and the ventrals. The predorsal scales vary from 12 to 14. The scaly appendages of the ventrals are fairly enlarged. In some large-sized specimens a couple of rows of scales at the base of the caudal fin are considerably enlarged as is seen in the specimen from Sahmaw.[1]

Colouration in alcohol is dark bluish-black or brownish above and pale white below the lateral line. Along the lateral line on either



Text-fig. 11.—Lateral view of a specimen of *Barbus clavatus burtoni*, subsp. nov. from Sahmaw in Upper Burma showing colour variation, × *ca.* ½.

side is present a more or less complete and distinct band in some specimens, while in others, as in the Sahmaw specimen, the free margins of a few longitudinal rows of scales are dotted with fine blackish pigment forming a meshy design (Text-fig. 11). The fins are dusky to whitish. The outer borders of the caudal fin are tipped with black.

[1] I am indebted to Dr. S. L. Hora for kindly allowing me to publish his manuscript drawing of the Sahmaw-specimen.

Remarks: *B. clavatus burtoni* may be easily distinguished from the typical form by its longer snout, shorter third spine of the dorsal fin, fewer scales along the lateral line, in a transverse series and before the dorsal fin, and by the colouration which is more dark than bright and silvery. According to Colonel Burton's field-notes, the fish grows "up to 7 lbs."

Distribution: Tributaries of the Mali Hka and Sahmaw in the Myitkyina District of Northern Burma.

Type-specimen: No. F. $\frac{11437}{1}$ preserved in the coll of the Zoological Survey of India, Indian Museum, Calcutta.

Measurements in millimetres:

	Sahmaw	Mali Hka system		
Length of body without caudal ...	172·0	162·0	110·0	83·0
Height of body	42·0	41·0	30·0	25·0
Length of head	35·0	35·0	26·0	20·0
Breadth of head	23·0	21·0	14·0	11·5
Depth of head	28·0	27·0	19·0	15·0
Length of snout	11·5	11·0	8·0	6·0
Diameter of eye	8·5	9·0	7·5	6·0
Interorbital width	10·5	10·5	8·0	5·0
Height of dorsal fin	32·0	36·0	25·0	18·0
Length of pectoral fin	30·0	32·0	21·0	15·0
Length of ventral fin	26·0	29·0	19·0	13·0
Length of anal fin	28·0	25·0	18·0	11·5
Length of caudal fin	44·0	38·0	30·0	23·0
Length of caudal peduncle	29·0	30·0	22·0	15·0
Least height of caudal peduncle ...	16·0	18·0	12·0	10·0

Barbus chagunio (Ham. Buch.).

One specimen (125 mm.) from Phungin Hka: '*Chyet neng*'.

The occurrence of this species in the Burmese waters was unknown till its recent report from the Myitkyina District in Upper Burma by Prashad and Mukerji (45). The specimen under report agrees perfectly with the description of the Burmese specimens given by these authors.

There had been a certain amount of confusion in regard to the specific validity of *B. chagunio*, and the matter was discussed in detail by Hora (32). The relationship of the species *B. chagunio*

with *B. spilopholus* of McClelland had also been a matter of dispute. Quite recently it has been shown by Hora and Mukerji (38) that *B. spilopholus* is conspecific with *B. chagunio*. The species is sexually dimorphic. *B. spilopholus* with the prolonged anal rays and well developed tuberculated pads on the snout and the cheeks represents a male, while *B. chagunio* without such characters is a female.

The specimen from the Phungin Hka is a female. It has no definite pores or tubercles on the snout and the cheeks, nor the elongated anal rays.

According to Colonel Burton's notes the fish is said to grow "up to 2 lbs."

Barbus chola (Ham. Buch.).

One specimen (90 mm.) from Phungin Hka: '*Shalum shawng*'.

A very faint blackish mark is present in the middle of the caudal peduncle. Another deep black blotch behind the gill opening is characteristic of the Burmese specimens. The dorsal fin has a black mark along the anterior part of its base and another along the centre. Posteriorly the scales have a dusky spot.

Barbus sarana caudimarginatus Blyth.

One specimen (154 mm.) from Phungin Hka: '*Nga pawk*'.
One specimen (150 mm.) from Phungin Hka: '*Nga bupawk*'.
One specimen (180 mm.) from Phungin Hka: '*Nga tawt*'.

The three specimens, although they have different local names, are all referable to this species. According to Colonel Burton's field-notes '*Nga bupawk*' grows "up to ½ lb.", while '*Nga pawk*' and '*Nga tawt*' grow in weight "up to 2 lbs.", and "4 lbs.", respectively. Since all the specimens represent a single species, these weights must refer to different sizes and, presumably, ages of the fish.

The barbels are blackish dorsally and whitish below. Both the dorsal and the caudal fins are tipped with black. There are very fine blackish longitudinal lines along the sides.

Semiplotus semiplotus (McClell.).

One specimen (44 mm.) from Phungin Hka: '*Salep la*'.
One specimen (67 mm.) from Sinan Hka: '*Salep la*'.
One specimen (90 mm.) rom Phungin Hka: '*Shalum shawng*'.
One specimen (115 mm.) from Tang Hka: '*Udi*'.
One specimen (150 mm.) from Phungin Hka: '*Wudi*'.

According to Colonel Burton's field-notes, in young stages the species is locally believed to represent a "small variety" and known as '*Salep la*'; but when the fish grows to a weight from "4 lbs. to 7 lbs." it is known by the name '*Udi*' or '*Wudi*'.

In all the specimens under report there are from 9 to 12 pores on either side of the snout. The last undivided dorsal ray is slightly longer or shorter than the length of the head according as the specimen is grown-up or young. The same is true in regard to the length of the pectoral fins.

Genus: **Rohtee** Sykes.

Most of the earlier ichthyologists adopted the name *Osteobrama* Heckel in preference to *Rohtee* Sykes. Hora (23) has already discussed the matter and has pointed out that Sykes' work (51) was published in 1841, while Heckel established his genus *Osteobrama* in 1843, and that according to the International Rules of Zoological Nomenclature Sykes' genus *Rohtee* has priority over *Osteobrama* of Heckel.

Recently, Tchang (52) has established a genus allied to *Rohtee* (=*Osteobrama*) which he calls *Parosteobrama* to accommodate two specimens of his *P. pelligrini* collected from 'Se-tchuan' (Szechuan) in China. He has defined the genus as follows:

"Corps comprimé; bouche termnale et verticale lèvres cornées; linge latérale plus rapprochée du ventre que du dos; dents pharyngiennes sur 3 rangées; vessie natatoire en 3 parties; dorsale débutant plus près de la caudale que du bout du museau, son troisième rayon simple ossifié, mais sans denticulations; anal longue; abdomen tranchant.

Ce genre est voisin de *Osteobrama* Heckel (*Rohtee* Sykes); il s'en distingue par ses lèvres cornées et par la vessie natatoire en 3 parties."

From the generic definition of *Parosteobrama* as well as from the illustrated description of the species, *P. pelligrini* I find that Tchang has considered the horny jaws and the tri-chambered air-bladder to be the chief distinguishing features.

In certain species of the genus *Rohtee* there is an indication of horny pads on the jaws, and in *Parosteobrama* this condition is probably accentuated.[1]

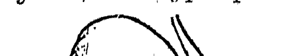
In my opinion, therefore, the horny covering on the jaws in fishes should, in most cases, be correlated with the environmental conditions of the fish and considered as an adaptive modification, which must vary in accordance with the necessity and the degree of adaptability.

In regard to the three-chambered air-bladder, Tchang observes "vessie natatoire en 3 parties, la premiere, ovale et arrondie aux deux bouts, la deuxieme plus longue que la premiere, la troisieme tres petite". Unfortunately, the author has not published any

[1] Since this report went to the press, Messrs. H. W. Wu and K. F. Wang's interesting paper—'Preliminary note on the lips of *Parabramis terminalis* (Richardson)'—published in *Contrib. Biol. Lab. Sci. Soc., China*, viii, *Zool. Ser.*, No. 10 (1932) has become available. In dealing with the structure of the epidermis of the lips of *Parabramis terminalis*, which are 'more or less horny in appearance' in specimens preserved in formalin or alcohol, the authors point out 'Tchang recognizes the particular structure as a horny lip (levres cornées) as a characteristic to his new genus in describing *Parosteobrama pelligrini* which is exactly synonymous of the present species. The so-called horny lip which is considered as a characteristic of the genus *Parosteobrama* is merely the highly developed epidermis of the skin covering the surface of upper and lower jaws, and the outer layers of epithelial cells have to become flattened and more or less cornified.'

This corroborates my view regarding the stability of the structure of the lips in *Parosteobrama* and the inference in respect of the validity of the genus.

illustration of this organ, which in view of its having an additional small third chamber is very interesting. As is well known, in most of the Cyprinoid fishes the air-bladder is bi-chambered. If, therefore, the tri-lobed air-bladder of *P. pelligrini* is proved by the future researches to be a constant feature, the fish will have a claim to a genus to itself. At this stage, however, this character cannot be stressed, inasmuch as the conclusion arrived at by Tchang is based on insufficient data. Moreover, the structure of the air-bladder, although considered to be of taxonomic value, has been known to vary considerably in many Cyprinoid fishes. Hora (24), who studied at some length the structures of the swim-bladder in certain Indian fishes, and specially of the various species of the genus *Garra*, found so much structural variation of this organ that he "was almost tempted to regard it as a specific character; but further examination showed that it is not only variable in the different species of the genus (*Garra*) but differs in individuals of the same species as well". I have examined the air-bladder of *Rohtee vigorsii*, the type-species of the genus, and also of *R. duvaucelii* and *R. feae* from Burma. In all these species I have found that there are only two chambers. The anterior chamber is medium-sized and more or less oval in outline, while the posterior one is fairly large and bean-shaped. The chambers are connected together by a narrow duct at a constriction whence the pneumatic duct arises (Text-fig. 12). The aforesaid three species, as also the rest of the species of the genus *Rohtee*, are not so well represented in the collection of the Indian Museum as to allow many specimens to be dissected, and it is, therefore not possible for me to judge the nature and range of variation of this structure in *Rohtee*, and to throw light on that of *Parosteobrama*.



Text-fig. 12.—Air-bladder of *Rohtee duvaucelii* (Cuv. & Val.) from the Myitkyina District, Upper Burma, ×2.

Another feature which Tchang has included in the generic definition of *Parosteobrama* is that the last osseous ray of the dorsal fin is not serrated, while in *Rohtee* it is usually serrated. In this connection reference may be made to a species of *Rohtee*, *R. cumna* (Tickell) Day in which the last osseous ray is simple. The fish was procured and reported by Colonel Tickell from Mandalay in Burma and considered as a valid species by Day. In his *Supplement to the Fishes of India* Day (15) has also re-defined the fish. Vinciguerra (53), however, accepts the validity of this feature in *R. cumna* with reserve and doubts the accuracy of the structure concerned in Tickell's original drawing of the species.

It is thus clear that to be certain about the validity of the genus *Parosteobrama* examination of further material is essential.

If such an examination reveals that the horny covering on the jaws, the tripartite condition of the air-bladder and the smooth nature of the last osseous ray of the dorsal fin are constant characters in a large series of specimens, *Parosteobrama* will then stand on a firmer basis.

Rohtee duvaucelii (Cuv. & Val.).

One specimen (105 mm.) from Phungin Hka: '*Shaping-naw-naw. kpa*'.

A curious confusion has found currency in the ichthyological literature, both earlier and modern, about the use of the specific name of this species. In 1844, Cuvier and Valenciennes described the species for the first time on page 77 of the 17th volume of their *Histoire Naturelle des Poissons* under the denomination "La Breme de Duvaucel: *Leuciscus Duvaucelii*" after the name of M. Alfred Duvaucel who collected the type specimen from "Nepaul". In the index of the same volume which is prefixed to the text, the name "La Breme d'Alfred (*Leuc. Alfredianus* nob)" is printed on page xvi. But the references affixed to this name are made to the description of *L. Duvaucelii* (p. 77) and to a coloured plate of the fish, No. 488 bearing the legend "*Leuciscus Alfredianus* nob". This discrepancy has resulted in the indiscriminate use of both the names, *duvaucelii* and *alfredianus* in the literature. Under the circumstances it is necessary to decide the question of the nomenclatural status of the two names used by Cuvier and Valenciennes for the same fish. So far as I am able to judge, the question of the "Law of Priority" of names or of "page precedence", as embodied in the International Code of the Zoological Nomenclature does not seem to arise here, nor is there any existing code of nomenclature which provides for such a case as that under consideration. In view of this fact the name *duvaucelii* under which the species was described should, in my opinion, have a natural right to exist, while *alfredianus*, a misnomer in all probabilty, should be eliminated from nomenclature.

In 1924 Myers (43) described a new species of *Rohtee*, *R. roeboides* from a single young specimen, 80 mm. excluding the caudal fin. The fish was collected from Monywa on the Chindwin river in Upper Burma. In a letter Dr. G. S. Myers wrote to me: "In working with the Burmese fishes you may have occasion to examine the cyprinoids I described in 1924. I have become dubious of the validity of *Rohtee roeboides* and *Barbus nicholsi*[1] and should welcome any attempt to properly place these fishes." But since in the absence of typical specimens it is not possible to arrive at

[1] I take this opportunity to point out in passing that Dr. D. Vinciguerra described an African species of *Barbus* under the name '*B. Nicholsi*' (*Ann. Mus. Civ. Stor. Nat. Genova,* LIII, p. 11, 1928). According to the International Rules of Zoological Nomenclature, Art. 35, *B. nicholsi* Vinciguerra (1928) becomes a homonym of *B. nicholsi* Myers (1924). I directed the attention of Dr. Vinciguerra to this point who agreed with me and kindly allowed me the liberty to propose a new name for his species. I have great pleasure in renaming the fish as **B. vinciguerra**

any definite conclusion in regard to the validity of these fishes and specially of *R. roeboides*, which concerns me in connection with my present studies, a request was made to Dr. J. T. Nichols of the American Museum of Natural History to send to the Indian Museum the types of these fishes for my examination. In reply Dr. Nichols kindly informed: "I regret that we cannot send you the types of Myers' species for examination, as we are not permitted to send such material outside the country". Thus I have had no chance of examining the type of *R. roeboides*. From Myers' description of the species, however, and after examining a large series of specimens of *R. duvaucelii* of different sizes as well as of the other species of the genus hitherto known from Burma, I have come to a provisional conclusion that *R. roeboides* is strikingly similar, if not identical with *R. duvaucelii*. Myers has already remarked that the species is "related to *Rohtee cotio* (Hamilton Buchanan) and *R. duvaucelii* (Cuvier and Valenciennes)" but "differs from *cotio* and *duvaucelii* in fewer scales (49) and shorter pectorals". It seems that Myers had no specimens of these two species before him for comparison with his species, and that he, therefore, depended considerably on Day's descriptions and figures of these fishes. He pointed out (p. 3 footnote): "Day's figure of *duvaucelii* (*alfrediana*) shows only 45 scales". Unfortunately, Day's descriptions and figures that are given in his *Fishes of India*, though standard references on the subject even today, have often been found to be inadequate and inaccurate for the purpose of understanding the precise limits of the various species; and any conclusion based merely on Day's observations and figures is likely to lead to a mistake.

In an earlier account of the fishes of the Myitkyina District in Upper Burma it has been already pointed out by Prashad and Mukerji (45) that in *R. duvaucelii* the lepidosis is very variable. The number of scales along the lateral line varies from 48 to 52 and there are 9½ to 10½ rows in a transverse series. This conclusion was arrived at after examination of a large series of specimens of the species from various localities. The presence of 49 scales along the lateral line in *R. roeboides*, therefore, does not, *per se*, preclude its assignment to *R. duvaucelii*. In all other respects, as far as I can judge, *R. roeboides* is indistinguishable from *R. duvaucelii*, except for the shorter pectorals. In all the specimens of *R. duvaucelii* that I have examined the pectoral fins either just reach the pelvics or extend slightly beyond them. The length of these fins and their relative proportions, specially in immature stages, can, however, be barely considered to be of specific value.

Barilius barna (Ham. Buch.).

One specimen (53 mm.) from Phungin Hka: '*Shapyin*'.
One specimen (65 mm.) from Tang Hka: '*Nyimaungiza*'.
One specimen (76 mm.) from Phungin Hka: '*Shapyin Pyinneu*'.
One specimen (80 mm.) from Tang Hka: '*Shapin*'.
One specimen (100 mm.) from Phungin Hka: '*Nga-chyet-neu*'.

Although the specimens from different localities as well as from the same locality are known by different local names as quoted

above, all undoubtedly belong to *B. barna*. The species is very variable in respect of the presence or absence of barbels, their numbers and the colour pattern, etc. Hamilton Buchanan (20), Günther (19) and Day (14, 16) observe that barbels are entirely absent in *B. barna*. I have examined a large series of specimens of the species from different places in India and Burma and have found that in some only minute maxillary barbels are present, while others are provided with both the maxillary and the rostral pairs. Specially among the specimens of the species from the Siju Cave and the Garo Hills in Assam, I have found many that are provided with one or both the pairs of barbels. Specimens from Burma under report are, however, devoid of barbels excepting the one from the Tang Hka (80 mm.) which has a rudimentary pair of maxillary barbels.

The species seems to be sexually dimorphic so far as it could be ascertained from the nature of the tuberculated structures on the snout, cheeks and on other parts of the body. In males the snout, the jaws, and the lower portion of the cheeks are thickly covered with pointed horny tubercles. In grown-up males 3 or 4 outer branched rays of the pectoral fins have soft cushion-like elevated ridges in the middle, situated dorsally. These pad-like structures are covered with minute tubercles. Some fine tubercles are also present on the last few branched rays of the dorsal fin of some of the males. In all the specimens the lower lobe of the caudal fin is longer than the upper. In Burmese forms this feature appears to be more pronounced than in the Indian individuals.

Broad, black vertical bands at the sides, which vary from 7 to 9, are present in all the specimens. The dorsal fin is edged with black and white, white on the top and black below. In most individuals the scales of the upper portion of the body have a fine blackish outline.

Barilius barila (Ham. Buch.).

One specimen (81 mm.) from Phungin Hka: '*Hkumpyi Ulum*'.
One specimen (81 mm.) from Phungin Hka: '*Shapyin*'.
Two specimens (95 and 105 mm.) from Tang Hka: '*Shapin*'.
One specimen (101 mm.) from Sinan Hka: '*Shapyin-Pyinzut*'.

It appears from the local names quoted from the field-notes of Colonel Burton that the fish is known by different names in the same and in different localities. Comparing certain local names of *B. barila* with those of *B. barna* it further appears that in certain localities, at any rate, the Kachins do not recognise them as two distinct species. For instance, both the species are known by the names '*Shapyin*' and '*Shapin*' at Phungin Hka and Tang Hka respectively, although elsewhere they have other local names.

Like the preceding species, *B. barila* is considerably variable in respect of certain characters, and at certain stages of growth the two species are so very similar that it is difficult to differentiate one from the other. In this connection mention may be made of *B. barnoides* described from 'Catchin' in Burma by Vinciguerra (53). I have examined a para-type of the species kindly presented to the Indian Museum by Dr. D. Vinciguerra. A thorough

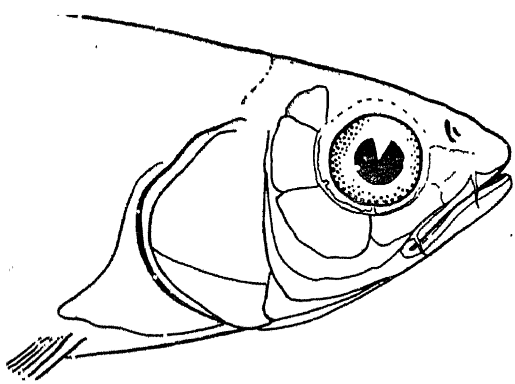
examination of this form and a detailed comparison with its allies has convinced me that *B. barnoides* is conspecific with *B. barila.* I have discussed this matter below under a separate heading.

Both Hamilton Buchanan (20) and Günther (19) have observed that in *B. barila* the barbels are absent, while according to Day (14, 16) "a small rostral pair is present". Of the earlier authors, Day has given undue importance to the nature and the number of the barbels in regard to the systematic classification of the different species of the barbelled Cyprinid genera. He has based his synopsis of the species of the genus *Barilius* on the presence or absence of barbels. But this has been found to be faulty which is due partly to Day's having overlooked the minute tendrils in many species of *Barilius*, and partly to his having been influenced by the *a priori* observations of other authors. Day's synopsis of the species of the genus *Barilius* can, therefore, be hardly rigidly adhered to in the matter of determining the specific identity. I have examined large series of *B. barila* from different localities and have found that in most cases there are two pairs of barbels, while two barbels and no barbels are found only in a few cases. In all the specimens from the Mali Hka system there are two pairs of barbels. The rostrals are nearly twice as long as the maxillary barbels.

The sides and the lower portion of the mandible as also the tip of the snout are covered with minute pores and tubercles. There are 10 to 12 vertical black bands along the sides. The posterior margin of the caudal fin is tipped with black.

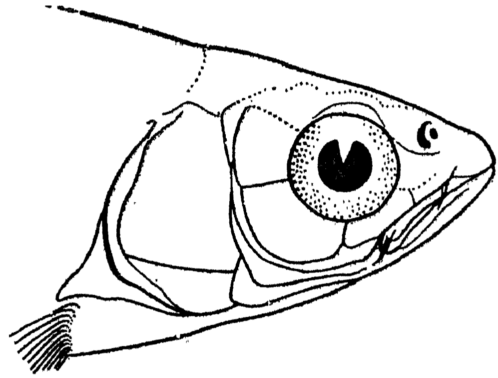
Remarks on the identity of *Barilius barnoides* Vinciguerra:

In 1889, Vinciguerra described the species from 'Catchin' in Burma, and characterised it chiefly by the absence of the barbels and the third suborbital bone not being in contact with the pre-opercular ridge. Having carefully examined a para-type of *B. barnoides* and studied the illustrated description of the species, I have come to the conclusion that *B. barnoides* cannot be considered as a valid species distinct from *B. barila.* In Vinciguerra's form, as I find from the para-type, both the rostral and the maxillary barbels are present which were somehow overlooked by the author. The accompanying illustration (Text-fig. 13) of the anterior



Text-fig. 13.—Lateral view of the head of a paratype of *Barilus barnoides* Vincig. showing relative positions of the third suborbital bone and the preopercular ridge, ×2.

portion of the body of the para-type of *B. barnoides* shows these barbels. The only other character that has been used by Vinciguerra in separating his species from *B. barila* is that in the former the third suborbital bone is not in contact with the preopercular ridge, while in the latter it is said to be in contact. I have examined a large series of *B. barila* of different sizes and from different places and have found that the bones under consideration are very variable in shape and size, etc., irrespective of age and locality; and consequently, their relative positions are also variable. In most cases the third suborbital bone does not lie in contact with the preopercular ridge or according to Day (14, 16) it "nearly" touches the latter (Text-fig. 14). Considering the variability in structures and the relative positions of the third suborbital bone and the preopercular ridge in *B. barila*, I am unable to attach any importance to one bone *touching*, *nearly touching* or *not touching* the other. Leaving aside the questions of the barbels and the position of the third suborbital bone, I find no other character in *B. barnoides* that can be taken into consideration in separating it from *B. barila*.



Text-fig. 14.—Lateral view of the head of one of Day's specimens of *Barilius barila* (Ham. Buch.) showing relative positions of the third suborbital bone and the preopercular ridge, $\times 3\frac{1}{2}$.

In reaching a conclusion regarding the affinity of his species, *B. barnoides*, Vinciguerra seems to have depended considerably on the short and inadequate descriptions of the allied species given by Günther, Day and others, and this induced him to place his species, which he believed to be non-barbelled, closer to the so-called non-barbelled form, *B. barna*, rather than to *B. barila*, characterised so far with a pair of rostral barbels. From the foregoing accounts of *B. barna* and *B. barila* it is, however, clear that they are different from what they have been understood by Günther, Day and others, and their affinities with related species of the genus must, therefore, be different. At the state of our present knowledge of the three species, *viz. B. barna*, *B. barila* and *B. barnoides*, it is not possible to recognise Vinciguerra's species as distinct from *B. barila*.

In 1893 Boulenger (4) relegated *B. barnoides* to the synonymy of *B. ornatus* Sauvage without assigning any reasons for it. As I am not familiar with the form *B. ornatus*, I am unable to make any comment on its affinity with *B. barnoides*. It seems to me probable, however, that Boulenger knew *B. barnoides* only from Vinciguerra's description and figure.

Danio (Danio) aequipinnatus (McClell.)

One specimen (80 mm.) from Tang Hka: '*Nga bit*'.
Two specimens (61 mm.) from Phungin Hka: '*Salap la*'.
One specimen (51 mm.) from Sinan Hka: '*Nga wan*'.
One specimen (30 mm.) from ? : ?

Although at different places different local names are used, all the specimens listed above belong to this species. The specimens have the characteristic colouration of the species and a small flake of a metallic blue near the upper angle of the opercles. In some individuals the lower jaw is papillated.

In 1907, Regan (47) described a new species of *Danio*, *D. browni* from the Northern Shan States in Upper Burma. I have examined the type-specimens of this species preserved in the collection of the Indian Museum, and have found that *D. browni* is strikingly similar to *D. aequipinnatus*: I do not find any stable character that can be taken into consideration in differentiating Regan's species from the other. *D. aequipinnatus* is such a variable species, as I find from an examination of large series of specimens from various places in India, Burma and Siam, that it seems impossible to recognise *D. browni* a distinct form.

FAMILY: BELONIDAE.

Xenentodon cancila (Ham. Buch.).

One specimen (205 mm.) from Tang Hka: '*Singawng tang*'.
One specimen (203 mm.) from Phungin Hka: '*Singawng tang*'.

Two indistinct blackish spots are present above the base of the pectoral fins.

According to the field-notes of Colonel Burton the species is said to grow "up to 3 lbs." The fish is known to grow to a fairly big size. Day (14) observed that it attains at least a foot in length.

FAMILY: NANDIDAE.

Badis badis (Ham. Buch.).

One specimen (40 mm.) from Phungin Hka: '*Nga-teng*'.
One specimen (57 mm.) from Tang Hka: '*Nkrai daw*'.

There are 10 to 11 vertical black bands along the sides. The dorsal fin is tipped with white. The outer margin of the ventrals is blackish.

The species is very variable in respect of the number of spines of the dorsal fin and of the different fin rays. The nature of the lateral line and the colour pattern are also variable.

FAMILY: MASTACEMBELIDAE.

Mastacembelus armatus (Lacép.).

One specimen (140 mm.) from Phungin Hka: '*Nga lapu*'.
One specimen (200 mm.) from Tang Hka: '*Shayu*'.

Both the specimens are young and they belong to the same species, although they are known by different local names. The fish is said to grow "up to 7 lbs."

FAMILY: OPHICEPHALIDAE.

GENUS: **Ophicephalus** Bloch.

In a recent paper Myers and Shapovalov (44) have shown that in view of the records of occasional absence of the ventral fins in *Ophicephalus gachua* Ham. Buch., *Channa* Scopoli (1777) which has so far been separated from *Ophicephalus* Bloch (1794) chiefly by the absence of the ventral fins cannot be regarded as a phylogenetic entity distinct from *Ophicephalus*, and that according to the relevant rules of the Zoological Nomenclature, the name *Ophicephalus* must be superseded by *Channa*. Although I thoroughly agree, as one must, with the views of Myers and Shapovalov I am for the present retaining *Ophicephalus* for its being an eminently suitable and so very well-known a name. Recently Herre (21) has also retained this name.

Ophicephalus gachua Ham. Buch.

One specimen (147 mm.) from Phungin Hka: '*Khumpup Nga*'.'

The species is perhaps the hardiest of all its relatives. It has been observed by Deraniayagala (17) that "*Ophicephalus gachua* flourishes in ponds rendered so stagnant as to prove toxic to most fishes. The swarms of tadpoles and mosquito larvae which thrive in these ponds supply food for the adults and fry respectively. The fish is very hardy and exceedingly active on land, progressing by series of leaps. It propels itself into the air by bending its body, planting its tail on the ground and straightening itself with a jerk, and it is a common sight to find these fishes crossing overland, while the pond they inhabit is baled dry by villagers in search of fish". It has also been found in Ceylon to be able to "withstand a considerable range of temperature from the warm waters arising from the hot springs at Kanniya (E. P.) to the cold waters of Diyatalawa (U.P.)".

According to the field-notes of Colonel Burton the species grows "up to 2 lbs." This requires confirmation. So far as I am aware the fish hardly attains that size and Day's remarks about its attaining "at least 13 inches" is probably an over-statement.

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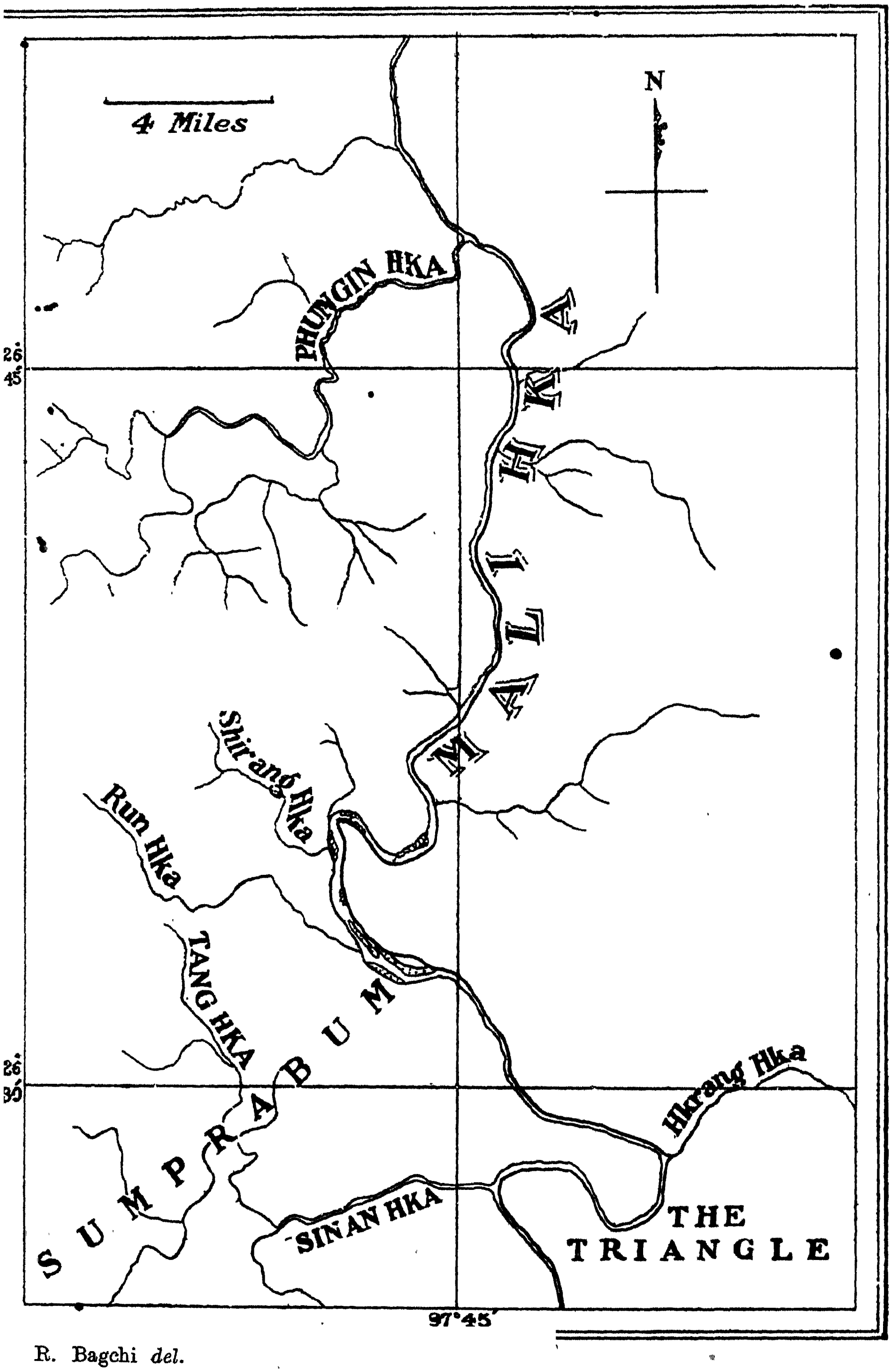

R. Bagchi *del.*

Sketch Map showing the provenance of Lt.-Col. R. W. Burton's collections of fishes from the tributary streams of the Mali Hka River in Upper Burma.

[*From the* Journal of the Bombay Natural Hist. Soc., *December* 15, 1933.]

REPORT ON BURMESE FISHES COLLECTED BY LT.-COL. R. W. BURTON FROM THE TRIBUTARY STREAMS OF THE MALI HKA RIVER OF THE MYITKYINA DISTRICT (UPPER BURMA).

BY

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Zoological Survey of India, Indian Museum, Calcutta).

Part I.

(*With one map, 3 plates and text-figures* 1 *to* 3).

Introduction.

Burma is a land of surprises for the ichthyologist. Its fish fauna is very rich both as regards the number of individuals and in the variety of forms. In addition to a number of endemic species, it includes forms which are identical with or related to Indian fishes, particularly those found in the adjacent provinces of Bengal and Assam; while there are others which are essentially Chinese or Indo-Australian in their affinities. The inland fish-resources of the country are enormous, and fisheries, both in Upper and Lower Burma, which materially "contributed to the revenue of the country before the days of the British occupation, are still one of the most profitable of the assets of the Province".[1] Dr. Francis Day's *Report on the Fresh-water Fish and Fisheries of India and Burma* (1873) includes a valuable account of these fisheries and may be referred to in this connection.

Unfortunately, our knowledge of the ichthyology of Burma is still very limited. Apart from Day's *Fishes of India* and the fish volumes in the *Fauna of British India*, which include accounts of only a certain proportion of both the endogenous and exogenous Burmese fishes, no exhaustive account of the freshwater fishes of this country, based on an extensive faunistic survey, has so far been published. The following reports dealing with the fishes of Burma may be specially mentioned.

1. The name of Major Berdmore will always remain associated with the fish-fauna of Burma, as he was perhaps the first naturalist to make a fairly representative collection of fishes from the Sitang River and its tributaries in the Tenasserim District of Lower Burma. A report on this collection was published by Dr. Edward Blyth in 1860.

2. The most important contribution to the Burmese ichthyology, after Blyth's account of the fishes of the Sitang R

[1] *The Imperial Gazetteer of India* (New ed.), IX, p. 208 (1908).

is that of Dr. D. Vinciguerra (1889), which appeared about thirty years later. This excellent report is based on the extensive collections made by M. Leonardo Fea during his travels through the different districts of Burma.

3. In order of publication Dr. G. A. Boulenger's (1893) "List of fishes collected by Mr. E. W. Oates in the Southern Shan States and presented by him to the British Museum" is the next account of Burmese fishes.

4. Dr. N. Annandale's (1918) account of the "Fish and Fisheries of the Inlé Lake" is a unique contribution to our knowledge of the fish and fisheries of the Burmese lakes. The collections which were made by him chiefly in the Inlé Lake and in the neighbouring fresh-waters of the Hehó basin in the Southern Shan States, comprise amongst others a number of remarkable endemic lake forms.

5. A collection of fishes from the hitherto unexplored mountain streams of the Putao Plains (Hkamti Long) on the northern frontier of Burma, was made by Dr. Murray Stuart and reported on by Dr. B. L. Chaudhuri (1919). Several extraordinary and new forms were found in the collection.

6. Since Dr. Annandale's faunistic survey of the Inlé Lake, the Indawgyi Lake of the Myitkyina District in Upper Burma, the largest lake in the country, was explored by a party of the Zoological Survey of India, led by Dr. B. Chopra, in 1926. A more or less thorough survey of the lake and of the adjoining streams and freshwaters of the Indawgyi area and of certain other mountain-streams of the Myitkyina District was made, and the extensive collections, brought back by the party were reported on by Dr. B. Prashad and myself (1929). Several remarkable endemic forms found in the lake and the adjoining streams are dealt with in detail in this paper.

7. Of a number of occasional reports on small collections of Burmese fishes published from time to time by Dr. S. L. Hora, his revision of the "Loaches of the genus *Nemachilus* from Burma" (1929) is of the greatest value.

Besides these above mentioned important publications which deal exclusively with the Burmese fishes, other small but useful notes and lists have also been published by various authors from time to time. The existing accounts of the fishes of the countries lying in the immediate neighbourhood of Burma, such as Siam, Yunnan etc., also have a considerable bearing on the fish fauna of Burma; but it has often been a matter of difficulty to the systematists to readily get at such scattered references. Dr. G. S. Myers (1924) published a list of references on the ichthyology of Burma; but this list, though very useful, is not exhaustive. The list of references given at the end of the present report is not intended as a complete bibliography, but it includes almost all the important publications on the fishes of Burma.

The present report is based on a collection of fishes made in March, 1930, by Lt.-Col. R. W. Burton in the three tributaries, *viz.* Phungin Hka, Sinan Hka and Tang Hka of the Mali Hka River of the Myitkyina District of northern Burma lying between

Lat. 26°25′ and 26°45′ (*vide* Map).[1] The Mali river flows due south through the Shan State of Putao (Hkamti Long) and passes through the wild hilly tracts inhabited by the Kachins to its junction with the 'Nmai Hka, the eastern branch of the Irrawaddy.[2]

Through the courtesy of Mr. S. H. Prater, the Curator of the Bombay Natural History Society, the collection was received by the Zoological Survey of India in June, 1930, and was kindly placed by Dr. S. L. Hora in my hands for study and report. Unfortunately, the pressure of other work has caused considerable delay in the preparation of a report on this collection.

The fishes dealt with in this paper are of special interest, as they were collected in a hitherto unexplored area of northern frontier of Burma, where streams and rivers are not easily accessible. In forwarding his collection Col. Burton remarked:

"To collect fish in these parts one wants more time at each halting place without thought of pushing on in hopes of catching fish for sport.

I have but very little to say concerning the fish. In these Kachin Hills all is food that comes to the people whether fish or flesh in any form. They come to search the river sides for all sorts of water insects and put them into the cooking pot. So all the fish are edible. The Kachins are expert at obtaining fish by traps and sieves of bamboo, by poisoning pools with crushed leaves, 'milk' of certain trees, etc., and by damming up streams. It is only the deepness and rapidity of the main streams and many tributaries also which save the fish supply from serious depletion.

I think there shall be 80 species available. I have only got 50. There are fish up these rivers which occur nowhere else. I feel sure new varieties will be forthcoming.

The country is very difficult and Mali river only accessible at certain places; but it is close to a motorable road for 50 miles north of Myitkyina. Further north it can only be got at here and there, until it gets to the Putao District where it has many tributaries and is more easily accessible. That is over 200 miles and I only went up 130 or so. I rather wish I had gone on, but I was poorly equipped for such a climate, incessant rain and thunderstorms, more difficult paths for miles etc. One wants plenty of time and no thought of doing anything else."

This throws sufficient light on the merit and the importance of the collection of fishes from these areas, and although there is only one new form in Colonel Burton's catches, they are, as he expected, none the less interesting. The collection contains 78 specimens comprising 32 different species belonging to the families, Siluridae, Amblycepidae, Sisoridae, Psilorhynchidae,

[1] According to Colonel Burton's field-notes the area from which he made collections is confined to Lat. 26°30′ and 26°45′. But on referring to a map of the localities concerned I find that the tributary Sinan Hka does not lie within this area. It is situated between Lat. 26°25′ and 26°45′.

[2] Hertz, W. A.—*Burma Gazetteer, Myitkyina District* (Rangoon, 1912).

Homalopteridae, Cobitidae, Cyprinidae, Belonidae, Nandidae, Mastacembelidae and Ophicephalidae. I give below a complete list of the species obtained from the tributaries of the Mali river:

Siluridae:
Silurus cochinchinensis Cuv. & Val.
Callichrous bimaculatus (Bloch).
Aoria cavasius (Ham. Buch.).
Aoria (Macronoides) dayi (Vincig.).

Amblycepidae:
Amblyceps mangois (Ham. Buch.).

Sisoridae:
Glyptothorax sinense (Regan).
Pseudecheneis sulcatus (McClell.).

Psilorhynchidae:
Psilorhynchus balitora (Ham. Buch.).

Homalopteridae:
Homaloptera rupicola (Prashad & Mukerji).

Cobitidae:
Botia hymenophysa (Bleek.).
Nemachilus botia (Ham. Buch.).
Nemachilus paucifasciatus Hora.
Nemachilus multifasciatus Day.
Nemachilus kangjupkhulensis Hora.

Cyprinidae:
Garra lamta (Ham. Buch.).
Crossochilus latius (Ham. Buch.).
Labeo (Labeo) dyocheilus (McClell.).
Barbus compressus Day.
Barbus tor (Ham. Buch.).
Barbus clavatus burtoni, subsp. nov.
Barbus chagunio (Ham. Buch.).
Barbus chola (Ham. Buch.).
Barbus sarana caudimarginatus Blyth.
Semiplotus semiplotus (McClell.).
Rohtee duvaucelii (Cuv. & Val.).
Barilius barna (Ham. Buch.).
Barilius barila (Ham. Buch.).
Danio (Danio) aequipinnatus (McClell.).

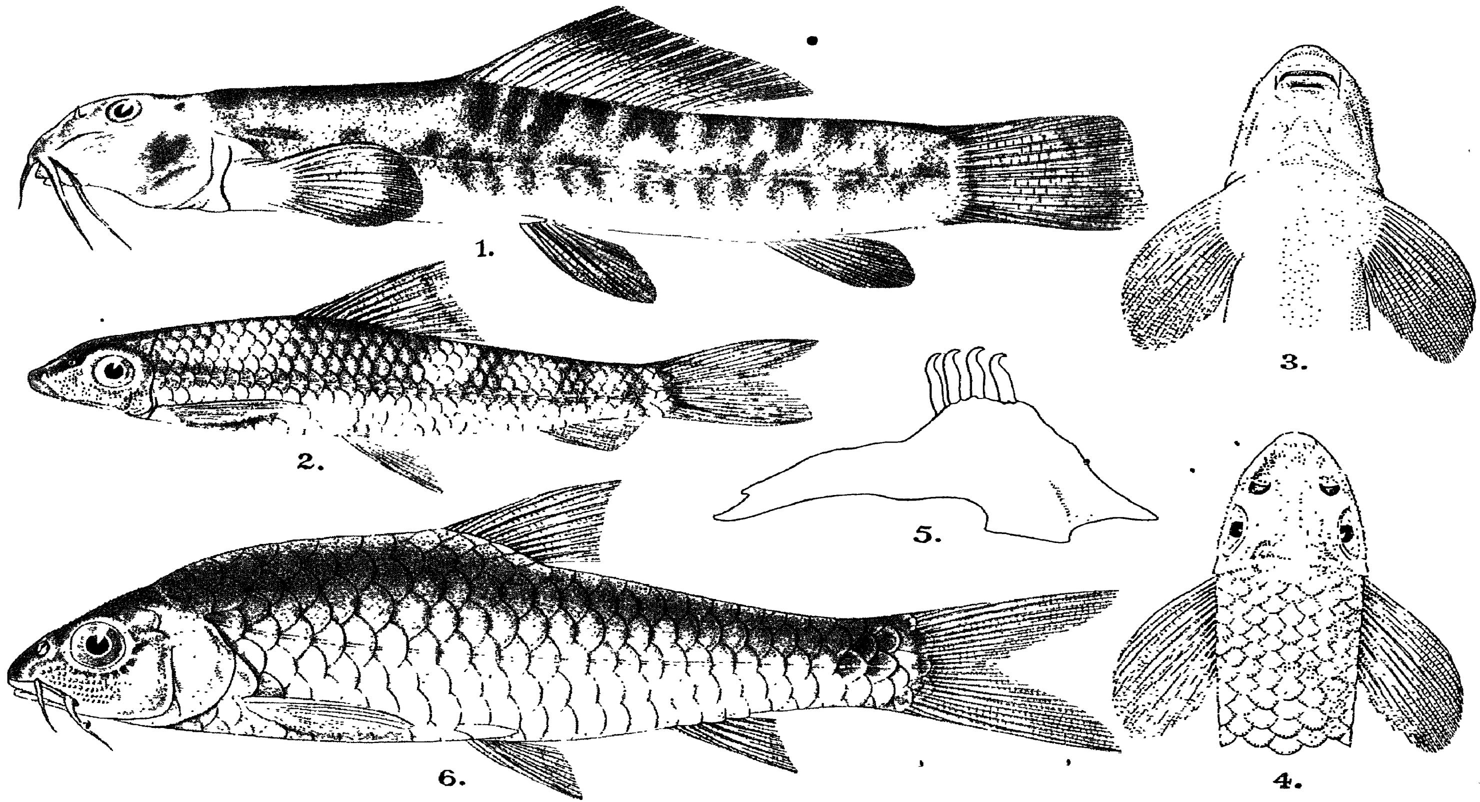
Belonidae:
Xenentodon cancila (Ham. Buch.).

Nandidae:
Badis badis (Ham. Buch.).

Mastacembelidae:
Mastacembelus armatus (Lacép.).

Ophicephalidae:
Ophicephalus gachua (Ham. Buch.)

Plate



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Of the 32 species enumerated above, *Aoria* (*Macronoides*) *dayi*, *Homaloptera rupicola* and *Nemachilus paucifasciatus* are endemic in Burma, while the following are recorded for the first time from the Burmese waters:

Glyptothorax sinense, *Psilorhynchus balitora*, *Nemachilus kangjupkhulensis*, *Labeo* (*Labeo*) *dyocheilus* and *Barbus compressus*.

Of these 5 species, *Glyptothorax sinense* is a Chinese species, while *Psilorhynchus balitora*, *Nemachilus kangjupkhulensis* and *Labeo* (*Labeo*) *dyocheilus* (*s. str.*) have so far been found in North-eastern Bengal and Assam only. The species *Barbus compressus* has been doubtfully known from Kashmir from a single specimen and has not so far been rediscovered. Its occurrence in Burma is of special interest.

The rest of the species from the tributaries of the Mali river are widely distributed in the streams and rivers of India and Burma, and except for a variety of *Barbus clavatus*, which is described in this report as new, and appears to be an endemic form in Northern Burma, do not call for any special remarks.

All the specimens in Colonel Burton's collection are fairly well-preserved and most of the species are represented by a moderate number of specimens. Unfortunately, however, the method of tagging the specimens was faulty in that the fish have been tagged with wire passing right through the mouth. As a result, the jaws and the lips are in several cases badly damaged. As is well known, the characters of the mouth, the jaws and the lips are of great value in connection with the taxonomy of fishes, and proper care should, therefore, be taken by field-collectors in preserving and tagging the specimens. The easiest and the most suitable method of tagging is to pass the wire or the thread through the fleshy root of the tail.

In the systematic account of the different species of the Mali Hka fishes I have given detailed descriptions with additional notes and figures in such cases as have been found necessary. No attempt has been made to give lists of synonyms as most of the species are well-known and their synonymies are clear. Original and subsequent references have, however, so far as it was necessary, been cited. Under the caption of each species has been given a list of number of specimens represented in the collection together with their measurements, respective localities and Kachin names. I have made ample use of the field-notes of Colonel Burton which were received with the collection, and the local names of the different fishes and their weights etc. are as given in these notes.

In addition to the 32 species of fish from the Mali Hka system of which a list has been given above, the following genera and species have also been critically annotated or otherwise referred to in this report:

Amblyceps horae Prashad & Mukerji.
Glyptothorax conirostre (Steind.).
Glyptothorax botia (Ham. Buch.).
Glyptothorax dorsalis Vincig.

Glyptothorax burmanicus Prashad & Mukerji.
Parapseudecheneis Hora.
Parapseudecheneis paviei (Vaillant).
Psilorhynchus McClelland.
Psilorhynchus sucatio (Ham. Buch.).
Chopraia Prashad & Mukerji.
Botia berdmorei (Blyth).
Botia nebulosa (Blyth).
Garra Hamilton Buchanan.
Discognathus Heckel.
Crossochilus latius punjabensis, subsp. nov.
Tor Gray.
Tor tor (Ham. Buch.).
Barbus clavatus McClelland.
Barbus spilopholus McClelland.
Rohtee Sykes.
Osteobrama Heckel.
Parosteobrama Tchang.
Parosteobrama pellegrini Tchang.
Rohtee vigorsii Sykes.
Rohtee duvaucelii (Cuv. & Val.).
Rohtee feae Vincig.
Rohtee alfrediana (Cuv. & Val.).
Rohtee cotio (Ham. Buch.)
Rohtee cumna (Tickell) Day.
Rohtee roeboides Myers.
Barbus nicholsi Myers.
Barbus nicholsi Vinciguerra.
Barbus vinciguerrae, nom. nov.
Barilius barnoides Vinciguerra.
Barilius ornatus Sauvage.
Danio browni Regan.
Ophicephalus Bloch.
Channa Scopoli.

I have to express my gratitude to Lt.-Col. R. B. Seymour Sewell and Dr. B. Prashad, the successive Directors of the Zoological Survey of India for kindly reading through the manuscript and making many valuable suggestions. To Dr. S. L. Hora I am greatly indebted for the facilities and help extended to me in the preparation of this report. The drawings illustrating the paper were executed under my supervision by Mr. R. C. Bagchi with care and precision, and for this my best thanks are due to him.

SYSTEMATIC DESCRIPTION.

FAMILY: SILURIDAE.

Silurus cochinchinensis Cuv. & Val.

One specimen (85 mm.) from Phungin Hka: *'Hkaram'*.

The maxillary barbels extend almost to the base of the ventrals. The mandibular barbels are about half as long as the head. The colouration is uniformly greyish, except for the head which is rather dusky. The maxillary barbels are black.

Callichrous bimaculatus (Bloch).

One specimen (118 mm.) from Phungin Hka: '*Buman*'.

The width of the head is almost equal to its length behind the middle of the eyes. The maxillary barbels reach the origin of the anal fin. The pectorals are almost as long as the length of the head behind the base of the maxillary barbels; its spine is as long as the head behind the posterior margin of the orbit.

The ground colouration of the body is dirty white with patches of dark brown to black spattered thickly all over. A faint dusky spot is present on the shoulder just behind the gill opening.

On examining a large series of *C. bimaculatus* from different places in India and Burma, I find that the species presents considerable variability, irrespective of locality and age, in regard to the colouration, lengths of the maxillary barbels and of the pectoral spines, and the depth of the body in relation to its length.

Aoria cavasius (Ham. Buch.).

One specimen (210 mm.) from Phungin Hka: '*Gawk Kyik*'.

The species is very variable, specially in regard to the lengths of the different barbels. In the specimen under report, as also in most Burmese individuals, the nasal barbels are shorter than the length of the head. In half-grown and young specimens the maxillary barbels do not as a rule extend beyond the anal fin, while in adults they reach the base of the caudal fin or even extend a little beyond it. Ordinarily, the outer mandibular barbels reach the tip of the pectorals, but they may, in some specimens, be much longer so as to meet the insertion of the ventrals. The inner mandibulars are almost invariably as long as the length of the head. The dorsal spine is shorter than the head and has minute serrations in the posterior upper third. The maxillary barbels are dusky above and whitish below. The characteristic black spot on the basal bone of the dorsal fin is present.

According to Day (14) the species attains "at least 18 inches in length". Colonel Burton has noted in his field-book that the fish grows "up to 20 lbs.".

Aoria (Macronoides) dayi (Vincig.).

One specimen (80 mm.) from Phungin Hka: '*Nbang Baw*'.
One specimen (78 mm.) from Tang Hka: '*Nga Hka*'.
One specimen (53 mm.) from Phungin Hka: '*Shing gyang*'.

The species was originally described and figured by Vinciguerra (53) from 'Meetan' and 'Toungoo' in Burma. In 1921, Hora (23) separated this species along with *Aoria affinis* (Blyth) and *A. merianiensis* (Chaudhuri) into a distinct sub-genus, *Macronoides*, which is characterised by "short barbels which do not exceed the length of the head, by possession of pores on the undersurface of the head and by the fact that the mandibular pairs of barbels are placed almost in a horizontal line". In 1929, the species was reported, for the second time from Burma, by Prashad and Mukerji (45) from the Indawgyi lake and rocky streams at Kamaing in the Myitkyina District. In the collections from the

Mali Hka system the fish is represented by three specimens as listed above. Unfortunately, they are not in a good state of preservation. I have, however, compared them with the other specimens of the species from the Myitkyina District and also with one of the type-series from 'Toungoo' kindly presented to the Indian Museum by Dr. D. Vinciguerra, and, so far as I can judge, all of them are referable to this species, although they have different Kachin names in the same and in different localities.

It appears that the number of serrations of the pectoral spines is variable. There are more serrations in the spines of the adults than in those of the half-grown and young individuals. The characteristic blackish patch at the free border of the dorsal fin and the one below its base are very faint. The body is clouded all over with fine brownish pigment.

FAMILY: AMBLYCEPIDAE.

Amblyceps mangois (Ham. Buch.).

One specimen (120 mm.) from Sinan Hka: '*Nga Yan*'.
One specimen (80 mm.) from Phungin Hka: '*Nga Yan*'.
One specimen (58 mm.) from Tang Hka: '*Uyan*'.

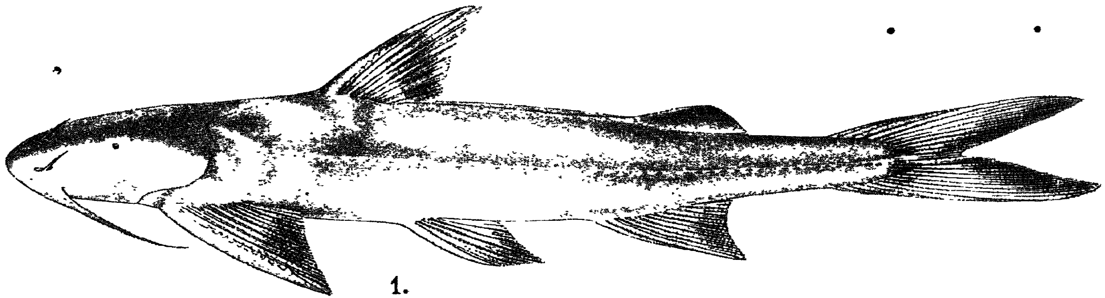
Among the Siluroid fishes that inhabit the hill-streams of India, Burma and elsewhere, there are few that can surpass *Amblyceps mangois* in the matter of its wide range of variability of the structure of the caudal fin, the length and the shape of the adipose dorsal and the nature of the jaws, etc. In fact, the differences between the two extreme forms of the species are often so very wide and well marked that nothing seems more contrary to the idea of natural species than to consider them conspecific; and this has been directly responsible for the creation of a number of so-called species under this genus.

Recently, both Dr. S. L. Hora and I have collected abundant material of *A. mangois* from the Sevoke stream in the Teesta valley at the base of the Darjiling Himalayas, which yields a series of intermediate forms and convincingly illustrates the perfect transition from one extreme form of the fish to the other. As Dr. Hora is making a thorough study of the structural peculiarities of the various divergent forms of *A. mangois*, and of its ecology and bionomics etc., I refrain from going into details.

The specimens from the Mali Hka system appear to be comparatively darker than usual. To my knowledge, the specimen from the Sinan Hka tributary is the largest (120 mm.) one of the species so far recorded.

Recently the range of distribution of *A. mangois* has been extended from India and Burma to Siam by Smith (50).

I take this opportunity to point out that through an unfortunate error, a new fish from the Myitkyina District of Upper Burma was described in 1929 by Prashad and Mukerji (45) as *Amblyceps horae*. On re-examination of the material it has been definitely ascertained that the species is referable to the genus *Olyra*. I am grateful to Dr. Hora for kindly drawing my attention to this point.



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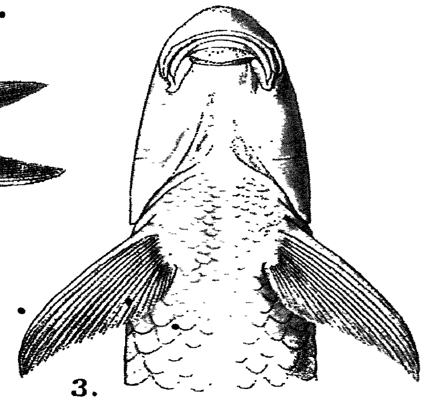

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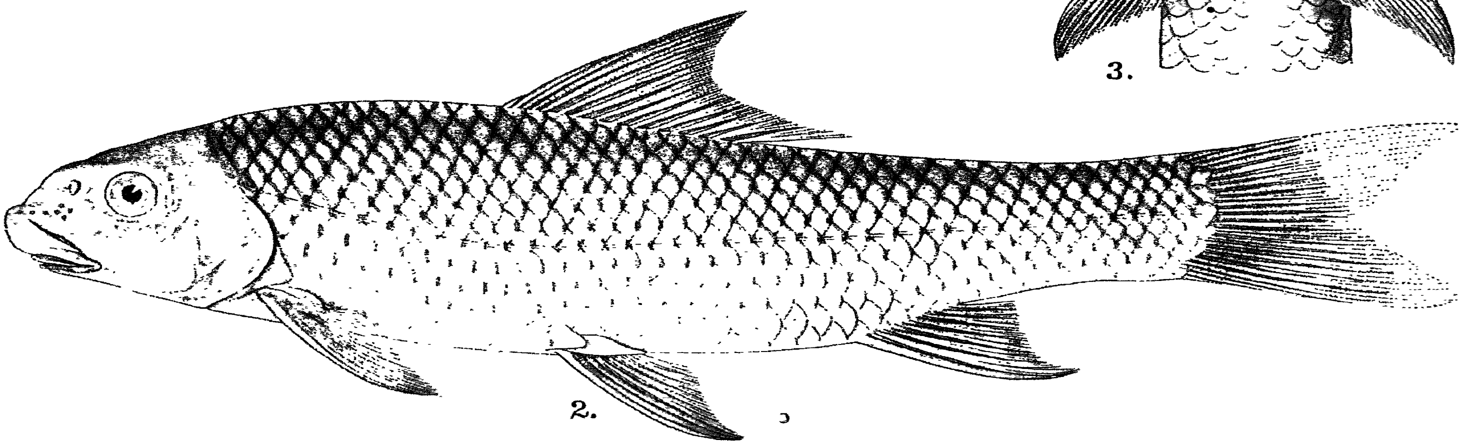

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FISH OF THE AL HKA, BURMA

FAMILY: SISORIDAE.

Glyptothorax sinense (Regan).

(Pl. II, Fig. 1).

One specimen (105 mm.) from Fhungin Hka: '*Nga shari*'.

Regan (48) described the species from a single specimen, 65 mm. in total length and collected from Tungting in China. He remarked that "this is the first Chinese species of the genus". But, so far as I know, Steindachner's *G. conirostre* is the first species of the genus to have been discovered in that country, and it was taken from the "mountain streams running into the Min River, Sze Chuen" in China and reported by Günther in 1892.[1]

In the collection of fishes from the Mali Hka system in Northern Burma there is a single specimen which agrees in all essential details with *G. sinense*; but it shows certain minor variations in regard to the relative proportions of the depth of the body, and the length of the head, etc. For comparison with the type specimen of *G. sinense* which is preserved in the British Museum (Nat. Hist.), the present form from Burma was sent to Mr. J. R. Norman, who very kindly remarked: "I have compared the specimen of *Glyptothorax* from Burma with the type of *G. sinense* (Regan) and, as far as I can judge, it is the same species. The differences in the relative proportions of depth of body and length of head are almost certainly due to the difference in size of the two specimens".

In view of the fact that the original description of the species is short and based on a single half-grown specimen, a detailed description and figures of the Burmese specimen are given below:

D. 1/6; A. 2/9; P. 1/9; V. 1/5; C. 17.

The head is longer than broad and nearly twice as broad as deep. Its length is contained a little over 4 times and the maximum height of the body about 6 times in the length of the body excluding the caudal fin, which latter is slightly shorter than the length of the head.

The snout is rather broadly rounded anteriorly and is as long as the postorbital portion of the head. The eyes are small, superior and situated almost in the posterior half of the head. The orbital width is contained nearly 10 times in the length of the head. The interorbital space is convex and is 3 times the diameter of the orbit and half the distance between the nostrils.

The maxillary barbels are fairly broad at their bases and extend a little beyond the base of the pectoral fins. The outer mandibular barbels are half as long as the maxillaries, while the inner mandibulars are much shorter. The nasal barbels extend to the middle of the distance between their bases and the anterior margin of the eyes.

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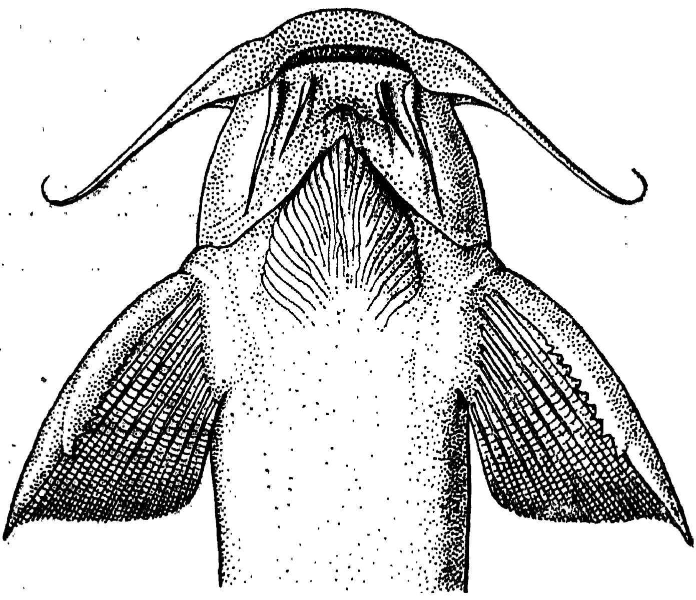
[1] In Pratt's *To the Snows of Tibet through China*, p. 245 (London, 1892).

The upper jaw is longer than the lower. The width of the gape of the mouth is almost equal to the length of the snout. The teeth are minute and sharp. In the upper jaw they are arranged in a single semi-lunar band, while in the lower jaw they are in two crescentic patches. The teeth of the mandible are longer than those of the maxilla. The lips are fairly well developed and more or less papillated. The adhesive structure on the chest (Text-fig. 1) is rhomboidal in shape and considerably longer than broad. It does not appear to have any definite depression in the centre. The anal opening is slightly nearer to the tip of the snout than to the base of the caudal.

The dorsal fin is inserted midway between the tip of the snout and the anterior margin of the base of the adipose dorsal. Its spine is very coarsely serrated, having 3 to 5 blunt denticulations on its posterior border. It is as long as the head behind the eyes. The longest ray of the dorsal is considerably longer than the greatest height of the body. The adipose dorsal is more or less triangular and about 3·5 times longer than high. Its base is nearly 2·5 times in the distance between its anterior end and the posterior margin of the base of the rayed dorsal. The pectorals are as long as the length of the head behind the nostrils. The spine is strong, dorso-ventrally flattened and has from 10 to 12 strong and sharp denticulations. The ventrals are inserted slightly behind the posterior end of the dorsal fin and are shorter than the pectorals. The anal fin is situated slightly in advance of the point of insertion of the soft dorsal. The paired fins are not plaited below.



Text-fig. 1.—Ventral view of anterior portion of body of *Glyptothorax sinense* (Regan) from the Mali Hka system, ×2.

The skin is more or less smooth except for a portion of the head which is finely tuberculate. The colouration of the specimen in alcohol is greenish brown with two faint and irregular darker patches, one below the rayed dorsal and the other below the adipose dorsal. The rayed dorsal has a broad, black longitudinal band in the middle.

Remarks: The tuberculate structure of the skin and certain other characters that the type-specimen from China has in common with *G. botia* (Ham. Buch.) induced Regan to place *G. sinense* nearest to *G. botia*. But from an examination of the larger specimen of the species from Northern Burma, in which the skin is more or less smooth, it appears to be more reasonable to consider *G. sinense* a closer ally of *G. dorsalis* Vinciguerra than of *G. botia*. In fact it is an intermediate form between *G. dorsalis* and *G. burmanicus* Prashad and Mukerji (45). The species is here recorded from Burma for the first time.

Measurements in millimetres.

Length of body without caudal	105.0
Height of body	18.0
Length of head	23.0
Breadth of head	18.0
Height of head	12.0
Length of snout	11.0
Diameter of eye	2.5
Interorbital width	7.0
Height of dorsal fin	16.0
Length of pectoral fin	22.5
Length of ventral fin	16.0
Length of anal fin	15.0
Length of caudal fin	21.0
Length of caudal peduncle	17.0
Least height of caudal peduncle	7.0

Pseudecheneis sulcatus (McClell.).

One specimen (110 mm.) from Sinan Hka: '*Nga hpai*'.

Until very recently the genus *Pseudecheneis* of Blyth embraced two species, *viz.*, *P. sulcatus* (McClell.) and *P. paviei* Vaillant. Of these two, *P. sulcatus*, the geno-type, is the only Indian species, having a range of distribution from the Darjiling Himalayas through the Abor Hills, the Khasi Hills, the Manipur Hills to Putao Plains (N.-E. Burma) and 'Catein Cauri' in the neighbourhood of Bhamo, while *P. paviei* is a Chinese species obtained at Lai-chow in Tonkin. In a recent paper by Hora and Chabanaud (34) the former author, after having thoroughly examined the type-specimen of *P. paviei*, has rightly assigned the Chinese species to a new genus, *Parapseudecheneis*, while the latter has given an elaborate description of *Parapseudecheneis paviei* and compared in detail its differentiating characters with those of *P. sulcatus*. *Pseudecheneis* thus reverts to a monotypic genus.

The specimen from the Sinan Hka does not differ in any way from the examples of the species from different places in India and Burma preserved in the collection of the Indian Museum.

FAMILY: PSILORHYNCHIDAE.

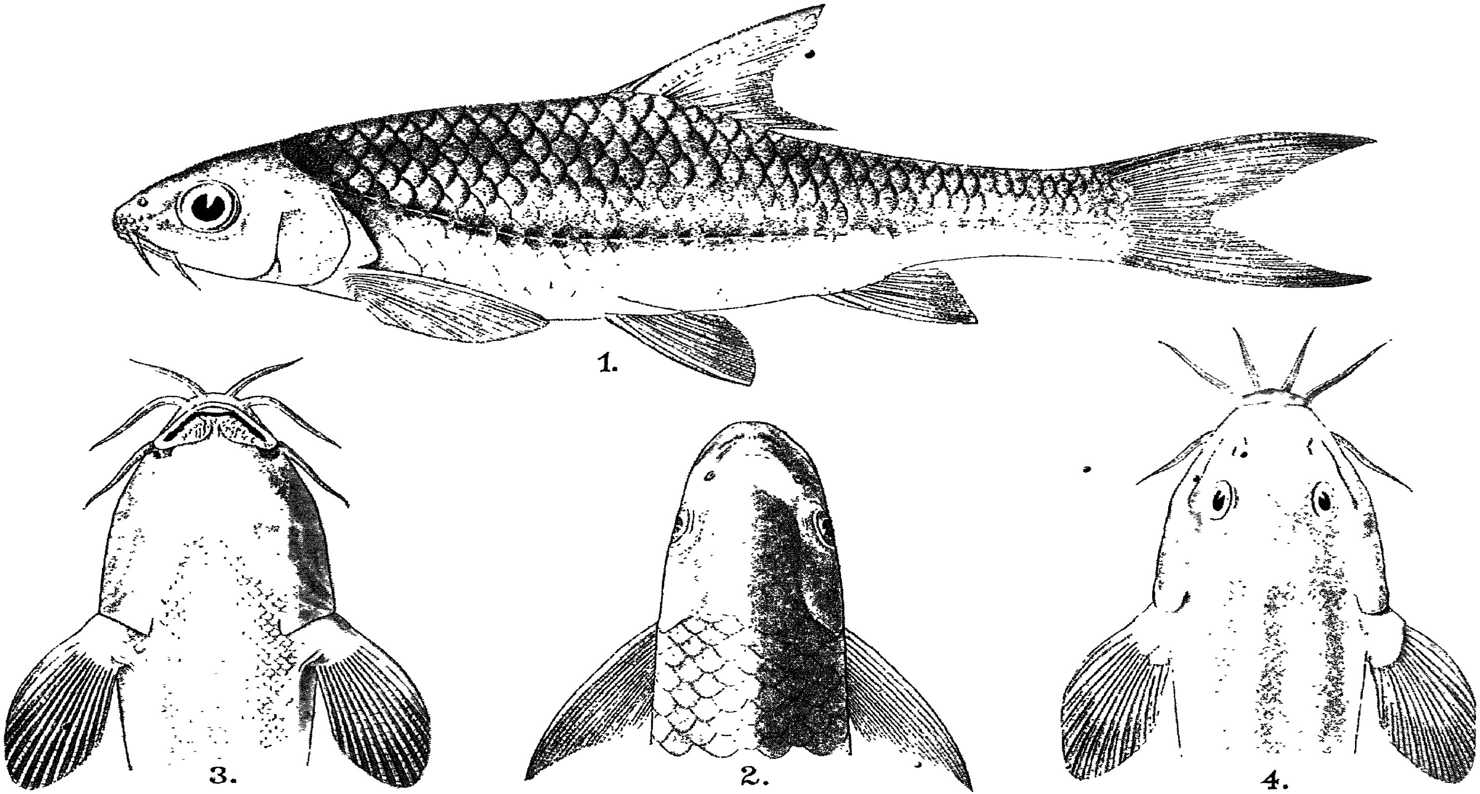
GENUS **Psilorhynchus** McClelland.

There had been a certain amount of confusion regarding the validity and systematic position of the genus *Psilorhynchus* of McClelland and of the two Indian species, *P. sucatio* and *P. balitora*. The question of selection of the type—species has also been rather a difficult one, since McClelland himself did not select the type, and of the two species referred to the genus, *P. sucatio*, the first one in order of McClelland's descriptions, was not definitely known to any earlier author, excepting Hamilton Buchanan who is the author of both the species. Below I have reviewed the views of the different authors in order to clear up the whole matter.

In his *Gangetic Fishes* Hamilton Buchanan (20) described for the first time the two species under the denominations '*Cyprinus sucatio*' (p. 347) and '*Cyprinus balitora*' (p. 348) from the "rivers of Northern Bengal" and those "towards the north-east Bengal" respectively. In order of description of the different species of Buchanan's composite genus *Cyprinus*, *C. sucatio* and *C. balitora* occupy the 85th, *i.e.* the last but one, and the 86th, or the last positions respectively. In Buchanan's original manuscript notes of the *Gangetic Fishes* it is stated on page 225 that he procured '*Cyprinus sucatio*' or '*Stolephorus sucatio*'[1] from 'Baruni' on the '20th March 1809', while the next species '*Cyprinus balitora*' ('*Stolephorus*') which is described on page 226, was obtained from 'Gualpara' on the '10th of June 1808'. Among his unpublished drawings there are illustrations of these two species which were subsequently published by McClelland in the 19th volume of the *Asiatic Researches* (pl. i, figs. 1 & 2).

In 1839, in the *Asiatic Researches* (41) McClelland proposed the genus *Psilorhynchus* for Buchanan's *C. sucatio* and *C. balitora*. Unfortunately for the definition of his genus, as well as for the descriptions of the two species, McClelland had no examples of these species before him except a single one of *P. balitora* which he received from 'Upper Assam', and he, therefore, depended largely on Buchanan's descriptions and the manuscript drawings. His definition of the genus is thus very short and inadequate and the descriptions of the two species are even less diagnostic than those given by Buchanan. Throughout the account of the *Indian Cyprinidae* in the *Asiatic Researches* McClelland did not select any type for any of his genera described therein, and, likewise, no type was selected by him for *Psilorhynchus*. Like Buchanan he,

[1] In his manuscript notes Hamilton Buchanan first used the generic name '*Cyprinus*' for the two species and later the name '*Stolephorus*'; and although he labelled his unpublished drawings as *S. sucatio* and *S. balitora* he never published the name '*Stolephorus*'.



R. B

FISH OF THE AL U. BURMA.

however, gave *P. sucatio* the first place, but unnecessarily changed the name of the second species, *P. balitora* into *P. variegatus*, presumably in reference to the variegated colouration of the fish.

In 1868, Günther in his *Catalogue of Fishes* (19) as well as in his *Introduction to the study of fishes* (1880) recognised the genus *Psilorhynchus* and included it in the group Homalopterina with the remark: "I follow McClelland in associating the following genus with *Homaloptera*. Besides its general outward appearance, scarcely anything is known of its characters, and it is not impossible that future researches will assign to it another place in the system" (1868, p. 343). He, however, recognised both the species *P. sucatio* and *P. balitora* without further comment; but it appears that Günther did not examine any specimens of either of the two species.

In 1871, in his *Monograph of the Indian Cyprinidae* (11) Day assigned *Psilorhynchus* to the subfamily *Cyprininae* and published a more or less elaborate definition of the genus with the remark: "In removing this genus from the group of the *Homalopterinae* I must observe that I have only had opportunity of examining one of the two known species, the *P. balitora*, H. Buch. apud McClelland, and it does not appear at all impossible that the other, *P. sucatio*, H. Buch. may be destitute of an air-bladder and would thus form a distinct genus appertaining to the subfamily Homalopterinae". Thus Day also had no specimen of *P. sucatio* before him. He, accordingly, gave *P. balitora*, the known species, the first place in his descriptions (p. 106), and published a ventral view of the fish (pl. ix, fig. 1.).

In 1878, in his *Fishes of India* (14) Day maintained the genus *Psilorhynchus*, but recognised *P. balitora* as the only valid species. He remarked: "This genus, as illustrated by a single example described, is a connecting link between *Homaloptera* and *Discognathus*" (p. 527). He published a lateral (pl. cxxii, fig. 3) and a ventral view (pl. cxxi, fig. 7) of the fish. As for the other species, *P. sucatio*, Day doubtfully and wrongly relegated the form to the synonymy of *Homaloptera bilineata* Blyth[1] with the remark that the latter species "appears to be closely allied to Buchanan's fish from the rivers of Northern Bengal, which, however, is said to have the snout much longer than the remainder of the head" (p. 526).

In his *Fauna* volume (16) Day upheld the preceding views about the genus *Psilorhynchus* and the species *P. balitora*, but seems to have relinquished all doubts about *P. sucatio* being conspecific with *Homaloptera bilineata*. This can be clearly judged from his definite statement that *H. bilineata* is "found in Northern Bengal and the Tenasserim provinces" (p. 244). Day was fully aware of the fact that *H. bilineata* is restricted to "the Tenasserim provinces" of Lower Burma (1878, p. 526), and unless he considered *P. sucatio*, which occurs only in Northern Bengal, to be the same as

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[1] In its correct interpretation, *Homaloptera bilineata* Blyth is essentially an endemic form of Lower Burma (*vide*, Hora, S. L., 'Classification, Bionomics and Evolution of Homalopterid Fishes', *Mem. Ind. Mus.*, XII, No. 2, p. 288, 1932).

H. bilineata he would not have extended the range of the latter species to Northern Bengal.

In 1889, Vinciguerra (53) discussed the relationships of *P. sucatio* at some length and established that Buchanan's *Cyprinus sucatio* is not only not a synonym of *Homaloptera bilineata*, but it is not congeneric with it.

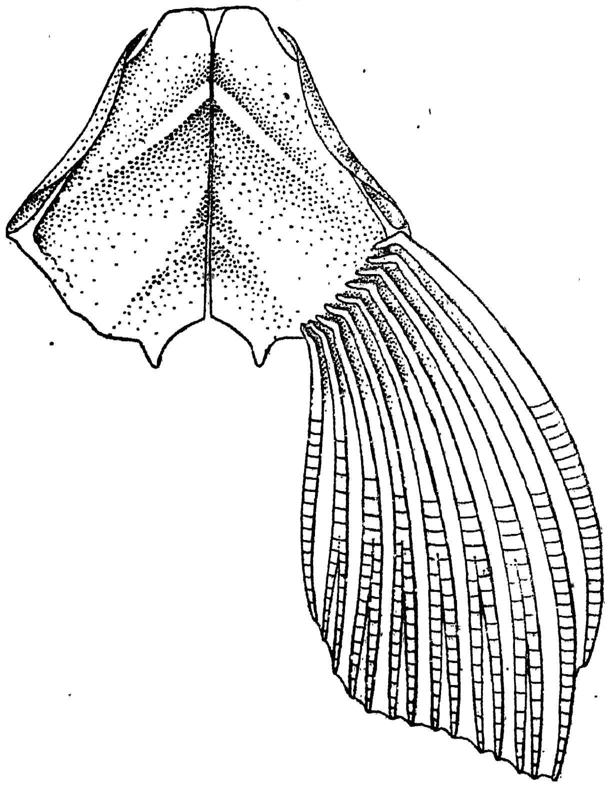
In 1919, Jordan in his *Genera of Fishes* (39) considered *Psilorhynchus* a synonym of *Homaloptera*, but selected *Cyprinus sucatio* of Buchanan as the logotype[1] of the former. In 1923, he (40) erroneously assigned the genus *Psilorhynchus* to the family Cobitidae.

In 1920, Hora (22) discussed the affinities of the genus *Psilorhynchus* at some length and pointed out that it is "abundantly distinct from the Homalopteridae"; and basing his arguments on the evidence then available to him, he referred *Psilorhynchus* to the family Cyprinidae and redefined it. But as he had only two old and rather deteriorated specimens of *P. balitora* before him and none of *P. sucatio*, his definition of the genus naturally remained to be further emended and the description of *P. balitora* to be greatly added to. He considered *P. balitora*, the only species known to him, as also to most of the earlier authors, to be the type-species of the genus *Psilorhynchus* (pp. 207-215). Subsequently, in 1921, he (25) published a detailed description (pp. 731-734) and excellent figures (pl. xxix, figs. 1 & 1a) of *P. sucatio* from three well-preserved specimens obtained from "the foot-hills of the Eastern Himalayas below Darjiling". In 1925, Hora (30) again referred to the question of the systematic position of *Psilorhynchus*, and ably discussed the views of the earlier authors. He definitely placed the genus in a distinct and well defined family which he called Psilorhynchidae. He remarked: "From the arrangement of the pharyngeal teeth and the presence of a number of simple rays in the paired fins it is clear that *Psilorhynchus* does not belong to the family Cyprinidae. The absence of barbels and the presence of a free bladder in the abdominal cavity separate it from the Homalopteridae. From the Cobitidae it is distinguished by the presence of large scales, by the presence of several simple rays in the horizontally placed paired fins, by the absence of barbels and its general facies" (pp. 459-460).

Recently, both Dr. S. L. Hora and I have collected abundant material of the species *P. sucatio* from pools and streams near Siliguri at the base of the Darjiling Himalayas and also a series of *P. balitora* from the Mahanaddi river at Siliguri and Sevoke stream in the Teesta valley. Messrs. G. E. Shaw and E. O. Shebbeare's collection of fishes from the different streams and rivers of northern Bengal has also considerably added to the number of examples of these species in the collection of the Indian Museum. I have thoroughly examined the extensive fresh materials of these two species, and I am fully convinced that

[1] According to Dr. D. S. Jordan, 'A *logotype* is one selected by the "first reviser".'

both the species *P. balitora* and *P. sucatio* are congeneric and valid. I am in full agreement with Hora's views that *Psilorhynchus* should be referred to a distinct family for the reasons which he has already pointed out. Further, in skeletal preparations of the pelvic fins and girdle of the species *P. sucatio* and *P. balitora*, I find that, unlike any member of the family Cyprinidae as also that of the Cobitidae, the basipterygium of *Psilorhynchus* has undergone complete ossification so as to form a perfect shield-like structure, somewhat similar to that found in the family Homalopteridae, but differing from it chiefly in the absence of lateral horns and the lateral foramina. Instead of having lateral horns for the attachment of muscles, the basipterygium of *Psilorhynchus* has the lateral marginal portion of the osseous element on either side rolled upwards and inwards to form grooves.[1] (Text-fig. 2).



Text-fig. 2.—Basipterygium of *Psilorhynchus balitora* (Ham. Buch.) showing its complete ossification into a shield-like structure and the upwards and inwards rolling up of bones at the lateral margins, ×10.

With regard to the question of selection of the type-species of the genus *Psilorhynchus*, the final decision, yet to be arrived at, must be judged in the light of the two different selections by 'subsequent designation' made first by Jordan and later by Hora. In 1919, in his *Genera of Fishes*, Jordan designated *P. sucatio*, the first species in order of both Buchanan's and McClelland's descriptions,

[1] Detailed studies on the modifications of the pelvic fins and girdles of the torrential fishes found in India and elsewhere are being carried on by me, and the results will be published later on.

as the logotype of the genus, but as has already been mentioned above, he considered *Psilorhynchus* a synonym of *Homaloptera*, and later in 1923 referred it to the family Cobitidae. It is evident that the true identity of the genus *Psilorhynchus* and its systematic position were not definitely recognised and understood by Jordan, nor was the true status of the two species referred to the genus by McClelland critically studied by him. In selecting *P. sucatio* as the type of the genus he, therefore, simply adhered to the 'first species rule' (Recommendation 's' of the Rule 'g' of Article 30 of the International Rules of the Zoological Nomenclature). Unfortunately, the selection of the first species as the type in this and in similar cases does not seem to be a happy one, for, it has to be admitted that though both *P. sucatio* and *P. balitora* are equally well-known now, in 1919 and till much later the species *P. sucatio* was known only from Buchanan's description and figure. *P. balitora,* on the contrary, was to most authors the better known of the two species, and McClelland, the author of the genus, actually examined a specimen of this species at the time he proposed the genus. This brings the case within the purview of the Recommendations '*n*' and '*g*' of the Rule of the Zoological Nomenclature mentioned above. According to these Recommendations, in selecting types by 'subsequent designation', preference is to be shown (i) to the 'best known' species and (ii) 'to a species which the author of the genus actually studied at or before the time he proposed the genus'.

In 1920, Hora, as already mentioned, examined a few specimens of *P. balitora* preserved in the collection of the Indian Museum, and, apparently unaware of Jordan's previous selection,[1] designated this species as the type of the genus *Psilorhynchus.* He did not assign any definite reasons for his selection of *P. balitora* as the type. It is presumable, however, that he adhered to the Recommendations '*n*' and '*q*'. But in view of the fact that there is no existing code of the Zoological Nomenclature that invalidates Jordan's first selection, unhappy though it was, and that both the species *P. sucatio* and *P. balitora* are equally well-known now, it seems, in my opinion, highly desirable to avoid confusion in future by accepting *P. sucatio* as the type of the genus.

The genus *Psilorhynchus* is represented in India so far by two species only, *viz., P. sucatio* and *P. balitora.* In 1920, Hora (22) published a description of a species of *Psilorhynchus* from a few immature specimen obtained by him in a hill-stream at Piphima in the Naga Hills in Assam. To him the species appeared to be new, but in view of the immaturity of the specimens he did not name the fish specifically. He, however, remarked: "the new species is readily distinguished from those previously known

[1] Dr. D. S. Jordan's *Genera of Fishes*, Part II was issued in July, 1919, while Dr. S. L. Hora's revision of the genus *Psilorhynchus* appeared early in 1920.

by its straight profile, by the absence of any grooves on the under surface of the head, and by the position of the eye, which is considerably nearer to the tip of the snout than to the posterior margin of the operculum" (p. 732, 1921). I have very thoroughly examined these specimens from the Naga Hills, and on comparing them with series of young specimens of *P. balitora* from the Sevoke stream in the Teesta valley and from elsewhere, I find that they do not differ in any essential characters from *P. balitora* except for the position of the eyes which are situated slightly more anteriorly in the head. In the absence of any specimens of *P. balitora* of the same size, for comparison, it is not possible to arrive at any definite conclusion, but I am inclined to believe that the Assamese specimens represent immature stages of *P. balitora*, which is known to occur in Assam.

Of the two species, *P. sucatio* and *R. balitora*, the former has been, as already mentioned, properly defined and figured by Hora; and I have nothing to add, except as regards the number of its pharyngeal teeth. Hora has remarked: "In the preparation of *P. sucatio*, one or two normal teeth are present and the remaining are of the nature of flat teeth with truncate crowns. The apex of such flat tooth is somewhat crenulated". But my preparations of the pharyngeal bones and teeth of *P. sucatio* definitely show 4 teeth, which are looked at the tip and arranged in a single row (pl. I, fig. 5). It seems probable, therefore, that the structures being very minute and delicate, 2 of the 4 teeth might have dropped off or broken in Hora's preparation.

It has already been pointed out elsewhere that owing to the paucity of material of *P. balitora* in 1920, it was not possible for Hora to give a detailed description of the species in his revision of the genus. In recent years, however, large series of fresh material of *P. balitora* have accumulated in the collection of the Indian Museum; and I take this opportunity to give below a more or less detailed description of the species for reference in future. All the drawings of the fish so far published are rather inaccurate and poor for the purpose of determining the diagnostic features. Fresh figures of the different views of the fish are, therefore, supplied with the description.

Psilorhynchus balitora (Ham. Buch.).

(Pl. I, figs. 3 & 4.)

One specimen (48 mm.) from Phungin Hka: '*Hang-hka*'.
One specimen (56 mm.) from Tang Hka: '*Uhtang*'.

D. 3/9; A. 2/5; P. 6/10; V. 2/7; C. 17 (excluding the small compact outer rays); L. l. 32-34; L. tr. 6 ($3\frac{1}{2}/2\frac{1}{2}$).

In its general facies the species has a very close resemblance to a Homalopterid fish. The dorsal profile rises from the tip of the

snout, forms a slightly concave margin between it and the anterior edge of the orbit, and then slowly rises to the insertion of the dorsal fin. Beyond the commencement of the dorsal fin the outline slopes down gradually to the root of the caudal fin. The ventral profile is more or less horizontal or very slightly convex. The under-surface of the head and the chest region are flat and horizontal like those of the Homalopterid fishes of fast currents.

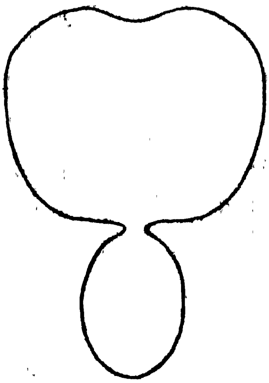
The head is rather small and conical. Its length is almost equal to or a little less than the maximum depth of the body below the dorsal fin, and is contained from 4.4 to about 5.3 times in the length of the body without the caudal fin. It is slightly broader than it is high. The snout is flat and obtusely pointed anteriorly, and its length is contained from 2 to nearly 2·5 times in the length of the head. There is a shallow depression across it in front of the eyes. In grown-up individuals, and specially in males, there are minute horny and pointed tubercles on the snout and on the cheeks. The eyes are large and situated almost entirely in the posterior half of the head. They are placed high in the head and are, therefore, scarcely visible from the ventral surface. In adult individuals the diameter of the eyes is contained nearly 3 times in the length of the head, while in young specimens, the eyes being comparatively large, the proportion of the diameter is about 2.5 times. The interorbital region is almost flat or very slightly concave. It is not so wide as the orbit. The gill openings are narrow. They extend from the anteriormost point of the lateral line down to a point in front of the ventral base of the pectoral fins, and vertically below the posterior margin of the orbit. The external nostrils are more or less large and are situated much nearer the anterior margin of the eyes than the tip of the snout.

The mouth is sub-ventral and its narrow opening is more or less transverse. The upper jaw overhangs the vestibulum of the mouth. Both the upper and the lower jaws are provided with sharp cutting horny edges, which suggest the fish's habit of scraping and rasping off food from the rocky bed of the streams it inhabits. The lips are moderately fleshy and continuous. The lower lip is capable of being everted out from the jaw. Minute post-labial fold-like structures are present at the angles of the lips. A distinct lateral groove passes on either side from the post-labial groove to the sides of the snout. Just behind and below the lower lip is a shallow depression, beset with minute papillae which probably acts as an accessary means of attachment.

The dorsal fin is inserted in advance of the ventrals and is situated much nearer the tip of the snout than the root of the caudal fin. It is almost as high as the depth of the body below it, and its outer margin is more or less straight and oblique. The pectoral fins are horizontally placed and are longer than the head: they have a somewhat rounded outer margin and they do not reach the ventrals. The ventrals are similarly situated and have a similar shape but are shorter than the pectorals: they are separated from the insertion of the anal by a considerable distance. The anal

fin is rather short and has a straight outer margin: when laid flat it almost reaches the root of the caudal fin. The caudal fin is considerably longer than the head and its own height: it is bilobed, the upper lobe in most cases being longer than the lower.

The lateral line is straight and runs to the middle of the base of the caudal fin. The scales are fairly large and arranged regularly on the body. There are 10 scales before the dorsal fin and 10 to 12 round the caudal peduncle. The anterior portion of the chest is devoid of scales, while the portion confined between the bases of the pectorals is covered with reduced scales. The anal opening is situated between the middle of the ventral fins.



Text-fig. 3.—Air-bladder of *Psilorhynchus balitora* (Ham. Buch.), ×12.

The air-bladder (Text-fig. 3) is, as already described by Hora (22), generally very much reduced but is more or less of the Cyprinid type. In most cases the larger anterior chamber is partly or wholly covered with a thick fibrous tissue. The pharyngeal bones and the teeth are very minute and slender. On each side of the pharyngeal bones there are 4 slender and more or less hooked teeth arranged in a single row like those of *P. sucatio*.

I have noted the colouration of the fish in its natural habitat and have found that it is very variable. The young specimens are more gorgeously coloured, having a very bright silvery ground with 6 to 8 shining dark patches on the dorsum and along the sides. In grown-up specimens these patches become somewhat diffused and the fish has a more or less uniform blackish-blue to brownish ground colour with irregular white patches here and there. The under surface is silvery. All the fins are diaphanous excepting the dorsal and the caudal fins. The dorsal has generally a blackish band towards the free margin, while the caudal has invariably two similar vertical bands. In some adult individuals these bands break up into irregular blackish patches.

Remarks: *P. balitora* is found in the fast streams and shallow rivers of Northern Bengal and Assam, specially where the bottom is rocky. I have never found the fish living in any sluggish stream with a muddy bottom. In the Sevoke stream and in the shallow, clear and rocky parts of the Mahanaddi river, I have observed series of *P. balitora* adhering tightly to the rocky substratum with the expanded paired fins and the chest applied to the rocks. Like other torrential fishes, it always points its head against the flow of the current. The variegated colouration of the fish harmonises so perfectly with the surroundings that it is hard to detect its presence even from a short distance. The species is here recorded from Burma for the first time.

Measurements in millimetres:

	Mali Hka System			Northern Bengal		
Length of body without caudal .	56·0	48·0	54·0	29·0	24·0	22·0
Height of body	12·0	10·0	13·0	6·0	5·0	5·0
Length of head	12·0	9·0	11·0	6·0	5·0	5·0
Breadth of head	9·0	8·0	9·0	5·5	4·0	4·0
Height of head	8·0	7·0	8·0	4·5	3·5	3·5
Length of snout	5·0	4·0	4·0	3·0	2·0	2·0
Diameter of eye	4·0	3·0	3·5	2·5	2·0	2·0
Interorbital width	3·0	2·5	2·5	1·5	1·5	1·0
Height of dorsal fin ...	11·5	10·0	11·5	6·5	6·0	5·0
Length of pectoral fin ...	14·0	12·0	12·5	7·5	7·0	7·0
Length of ventral fin ...	11·5	9·5	11·0	5·5	5·0	5·0
Length of anal fin	8·5	7·0	8·0	5·0	4·0	3·5
Length of caudal fin ...	12·5	11·0	12·5	8·0	7·0	5·0
Length of caudal peduncle ...	6·0	5·0	6·0	4·0	3·0	3·0
Least height of caudal peduncle	5·5	4·0	5·0	2·5	2·0	1·75

EXPLANATION OF PLATE I.

Fig. 1.—Lateral view of *Nemachilus botia* (Ham. Buch.) from the Mali Hka system, ×1¼.

Fig. 2.—Lateral view of *Psilorhynchus balitora* (Ham. Buch.) from the Mali Hka system, ×1¼.

Fig. 3.—Ventral view of the anterior portion of the body of the same, ×2.

Fig. 4.—Dorsal view of the same, ×2.

Fig. 5.—Pharyngeal bone and the teeth of *Psilorhynchus sucatio* (Ham. Buch.), ×30.

Fig. 6.—Lateral view of *Barbus compressus* Day from the Mali Hka system, *ca* Nat. size.

EXPLANATION OF PLATE II.

Fig. 1.—Lateral view of *Glyptothorax sinense* (Regan) from the Mali Hka system, *ca.* Nat. size.

Fig. 2.—Lateral view of *Labeo* (*Labeo*) *dyocheilus* (McClell.) from the Mali Hka system, ×⅝.

Fig. 3.—Ventral view of the anterior portion of the body of the same, ×⅝.

EXPLANATION OF PLATE III.

Fig. 1.—Lateral view of the type specimen of *Barbus clavatus burtoni*, subsp. nov. from the Mali Hka system, *ca* Nat. size.

Fig. 2.—Dorsal view of the anterior portion of the body of *Labeo* (*Labeo*) *dyocheilus* (McClell.) from the Mali Hka system, × ⅝.

Fig. 3.—Ventral view of the anterior portion of the body of *Nemachilus botia* (Ham. Buch.) from the Mali Hka system, ×*ca* 1½.

Fig. 4.—Dorsal view of the same. ×*ca* 1½.

(*To be continued*).

NOTES ON FISHES IN THE INDIAN MUSEUM, XLII, XLIII.

By SUNDER LAL HORA, *D.Sc.*, *F.R.S.E.*, *F.N.I.*, *Assistant Superintendent, Zoological Survey of India, Calcutta.*

XLII. ON THE SYSTEMATIC POSITION OF THE INDIAN SPECIES OF *SCAPHIODON* HECKEL.

Day[1] described five species from India in the genus *Scaphiodon* Heckel, and divided them into two groups on the presence or absence of barbels. The first group comprising two species—*S. watsoni* Day and *S. irregularis* Day—from the Sind Hills and the Salt Range, Punjab, is characterized by the possession of " A pair of maxillary barbels. Last undivided dorsal ray osseous, serrated ". From their descriptions, it is also clear that they possess 7 branched rays in the anal fin, as is characteristic of other species of the genus known from Baluchistan, Southern Persia, Mesopotamia and Syria. The second group comprises three species—*S. thomassi* Day, *S. nashii* (Day) and *S. brevidorsalis* (Day)—which are found in the Western Ghats as low as the Nilgiri Hills. In these forms the barbels are absent, the last undivided ray of the dorsal fin is smooth and the anal fin is generally provided with 5 branched rays. The distinguishing features of the two groups make it abundantly clear that they are not congeneric and that *Scaphiodon*, as recognised by Day, is a heterogeneous assemblage of diverse forms.

In his note on *Cirrhina afghana* Günther, Berg[2] showed that the Sind and Punjab species of *Scaphiodon* belong to *Cyprinion* Heckel which is characterized by the following salient features :—

i. Seven branched rays in the anal fin.
ii. A more or less developed scaleless furrow between the occiput and the origin of the dorsal fin.
iii. Dorsal with an osseous ray serrated behind and with 9-16 branched rays.
iv. Scales subcircular.
v. Barbels 2, angular.
vi. Intestinal canal very long, with many convolutions.
vii. Posterior chamber of the air-bladder long and narrow.

Berg also gave a preliminary list of all the species of *Cyprinion* belonging to the *watsoni*-group [small forms with (9) 10-11, mostly 10, branched rays in the dorsal and occurring in Southern Persia, Baluchistan, Sind and the Salt Range], with their respective synonyms and range of distribution. There would thus seem to be no uncertainty about the systematic position of the Indian species belonging to *Cyprinion* Heckel. For a general account and good figures of this type reference may be made to my[3] account of *Scaphiodon readingi*, which, according to Berg, is synonymous with *Cyprinion irregulare* (Day).

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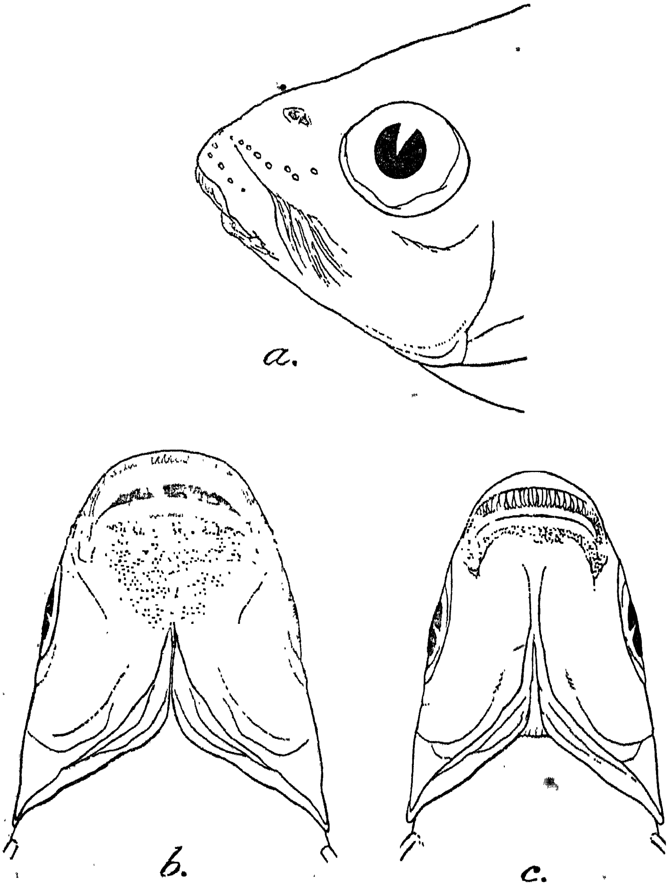
[1] Day, F., *Fish. India*, p. 551 (1877); ~~*Faun. Brit.*~~ *Ind.* Fish. I, p. 283 (1889
[2] Berg, L. S., *Rec. Ind. Mus.* XXXV, pp. 193-196 (1933).
[3] Hora, S. L., *Rec. Ind. Mus.* XXV, p. 379, pl. viii (1923).

Though Berg has recently shown that *Cirrhina afghana* Günther is a synonym of *Cyprinion microphthalmum* (Day), it may be noted that Day[1] was already familiar with the fact that Günther's species belonged to *Scaphiodon*, for, in referring it to the synonymy of *S. irregularis*, he observed " Not only does this fish differ from those of the genus *Cirrhina* in the character of its mouth, but it likewise possesses a serrated osseous ray in the dorsal fin ".



TEXT-FIG. 1.—*Osteochilus (Osteochilichthys) thomassi* (Day).

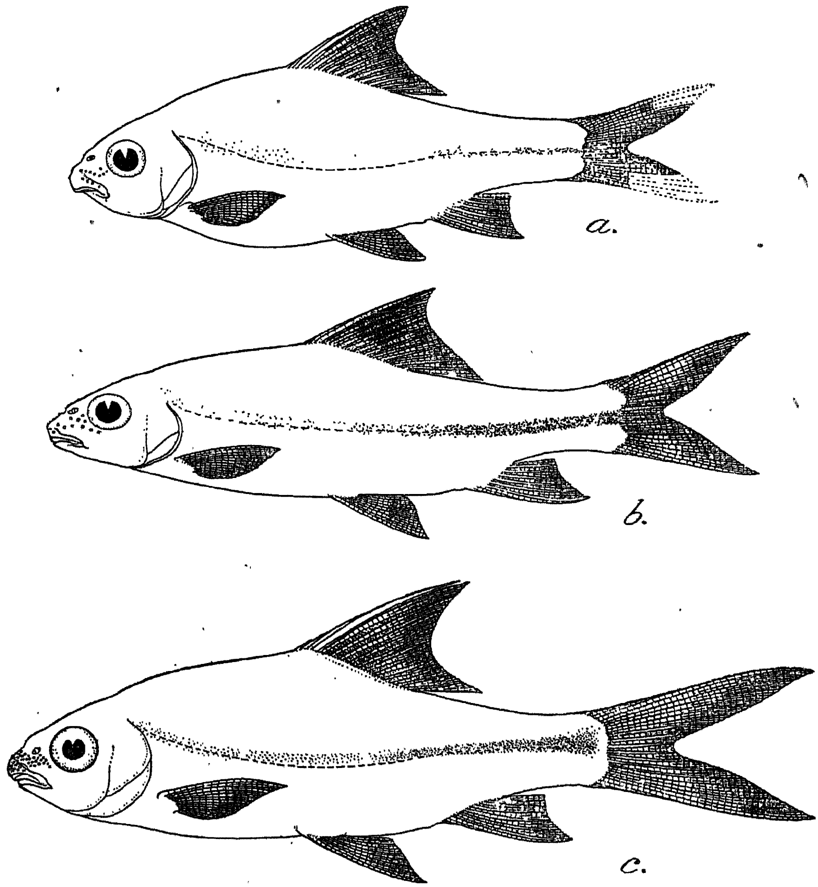
a. Lateral view of head of one of Day's specimens (No. 2192) : × 1⅝; *b.* Ventral surface of head of same : × 1⅝; *c.* Ventral surface of head of a young specimen (No. F12430/1) : × 3⅓.

The position of the three South Indian species is somewhat difficult to define, for they not only differ in fundamental characters from *Cyprinion* and allied genera, but also among themselves in several important features. For instance, in *Scaphiodon thomassi* the lips are stated to be discontinuous, " the upper one fringed. Large pores on the snout and upper lip, and a line of them continued to under the eye ". The

[1] Day, F., *Fish. India, Suppl.*, p. 807

last undivided ray of the dorsal is weak and articulated. The lips of *S. nashii* are " thin, without any transverse fold across the lower one. Snout in the adult covered by papillae ". In this species also the dorsal is without an osseous ray. In *S. brevidorsalis,* there are " three rows of large pores across the snout, and extending on to the preorbital bone ; knob at symphysis badly developed : a thin cartilaginous covering to both jaws. Upper lip crenulated". The last undivided ray of the dorsal fin is osseous, very strong and entire.

Fortunately, specimens of all the three species are present in the collection of the Indian Museum so I am in a position to give further

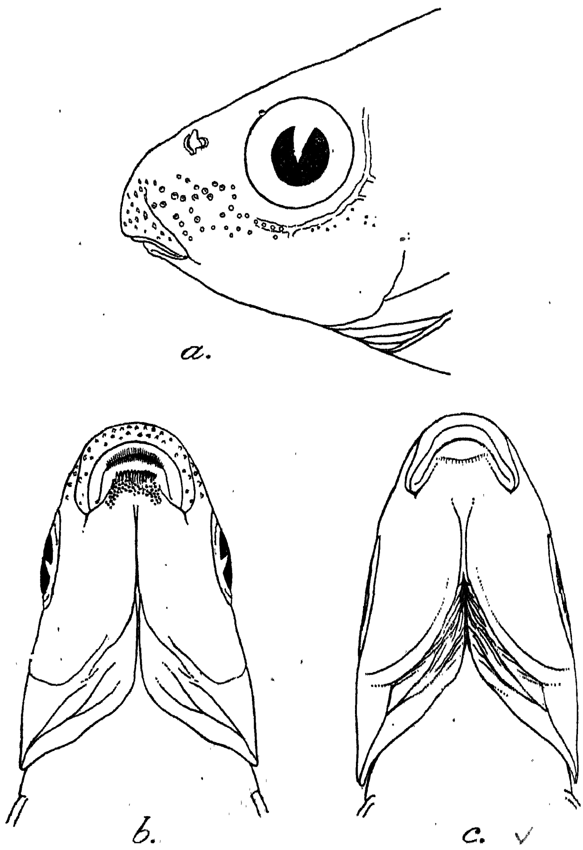


TEXT-FIG. 2.—Species of *Osteochilus* Günther from Peninsular India : Nat. Size.

a. Osteochilus (*Osteochilichthys*) *thomassi* (Day) ; *b. Osteochilus* (*Osteochilichthys*) *nashii* (Day) ; *c. Osteochilus* (*Kantaka*) *brevidorsalis* (Day).

details regarding their salient features. Of *Scaphiodon thomassi,* Day had two examples from South Canara. One of these (No. 2192), probably the original of his figure in the *Fishes of India,* is now preserved in the collection of the Indian Museum. I find (text-fig. 1 *b*) that the lips are continuous and fleshy at the angles of the mouth, the upper lip, the basal and adnate part of which is covered by the rostral fold, has a free and

pendulous portion which is markedly fimbriated. The lower lip is transverse, does not cover the jaw and is attached to it at a short distance behind the mouth, only the lateral portions near the angles of the mouth are free and continuous with the upper lip ; it is papillated along its anterior border which is followed by a transverse series of small



TEXT-FIG. 3.—*Osteochilus* (*Osteochilichthys*) *nashii* (Day).

a. Lateral view of head of the specimen No. F11145/1 from the Bhavani river : × 2 ; *b.* Ventral surface of head of same : × 2 ; *c.* Ventral surface of head of a young specimen from Shimoga, Mysore.

pores. There are oblique grooves on the sides of the snout running to the ventral surface which are more marked when the mouth is closed. Other features are as described by Day.

On further examination I find that the specimen from Coorg referred by me[1] to *S. thomassi* belongs to *S. nashii* and that one (No. F 12430/1) of the four specimens with broad mouth and fimbriated lips described by me[2] as *S. nashii* is referable to *S. thomassi* (text-fig. 1 *c*). The confusion had arisen owing to the fact that in the young of *S. thomassi* also the body is marked with a dark lateral band and the dorsal and anal fins are

[1] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 19 (1937)
[2] Hora, S. L., *ibid.*, p. 9 (1937

marked with dark bands (text-fig. 2 *a* & *b*). In spite of the common colour markings and uniformity in scale-counts and number of fin rays the two species can readily be distinguished by the structure of the mouth and associated parts and by the greater depth of body in *S. thomassi* ($3\frac{1}{2}$ in *thomassi* versus 4-5 in *nashii*).

In *S. nashii* the mouth is narrower, the lips are simple and continuous at the angles of the mouth; the portion of the lower lip between the lateral portions of the labial groove is considerably behind the tip of the jaw, to which it is firmly attached, and is plicated. Mukerji[1] redescribed this species from a specimen from the Bhavani River in the Nilgiri Hills. Attention may here be directed to a footnote by Day[2] on variation in the form of the snout in this species. He stated :—

"The mouth in this species alters so with age, that until I had compared specimens of my *Osteochilus Malabaricus* with gradations of *Scaphiodon Nashii* since obtained, I could not have believed in their being identical. In the young the jaws are compressed, each with a cartilaginous covering: the lips at the angles are thick and continuous, not continued across the chin. As age increases the mouth widens, the cartilaginous covering becomes more horny, and the colours of the fish alter."

It has already been pointed out by Mukerji that Day's *Osteochilus malabaricus* is probably a misnomer as he seems to have described no species under this name. However, one thing is clear that Day regarded a certain fish from Malabar allied to *Osteochilus* Günther. *S. thomassi*, with fimbriated lips, has certainly great affinities with Günther's genus. I shall refer to this later.

Scaphiodon brevidorsalis (text-fig. 2 *c*) is readily distinguished from the other two species referred to above in the possession of a strong dorsal spine. In the young stage, the upper lip is feebly but distinctly fimbriated and the lower lip is papillated (text-fig. 4 *b*), but with growth the upper lip becomes crenulated (text-fig. 4 *d*) as described by Day. In the structure of the mouth and the associated parts, this species is more or less intermediate between the other two, and there can be no doubt that the three forms have much in common to be included in a single genus.

As remarked above, Day's species of *Scaphiodon* from the Western Ghats are abundantly distinct from *Cyprinion* Heckel (=*Scaphiodon* Heckel) and somewhat allied to *Osteochilus* Günther. The latter genus was established by Günther[3] to accommodate a group of Cyprinid fishes from the 'East-Indian Archipelago' with the following characteristics:

"Scales rather large. Dorsal fin without osseous ray, with from thirteen to twenty-one rays, commencing in advance of the ventrals. Snout obtusely rounded, maxillary region scarcely thickened, and but slightly projecting beyond the mouth. Mouth transverse, inferior or subinferior, with the lips more or less thickened, fringed or crenulated; instead of the inner fold, as described in *Labeo*, the osseous part of the mandible forms a hard sharp transverse prominence; no symphysial tubercle. Barbels small, nearly always four. Anal scales not enlarged. Anal fin very short. Pharyngeal teeth 5.4.2—2.4.5."

"Snout sometimes with horny tubercles which periodically fall off, leaving their former bases as shallow round depressions (pores)."

Day[4] included three species from Burma under *Osteochilus*, but on an examination of the specimens in the collection of the Indian Museum I find that Day's specimens of *O. chalybeatus* (Cuv. & Val.) do not belong

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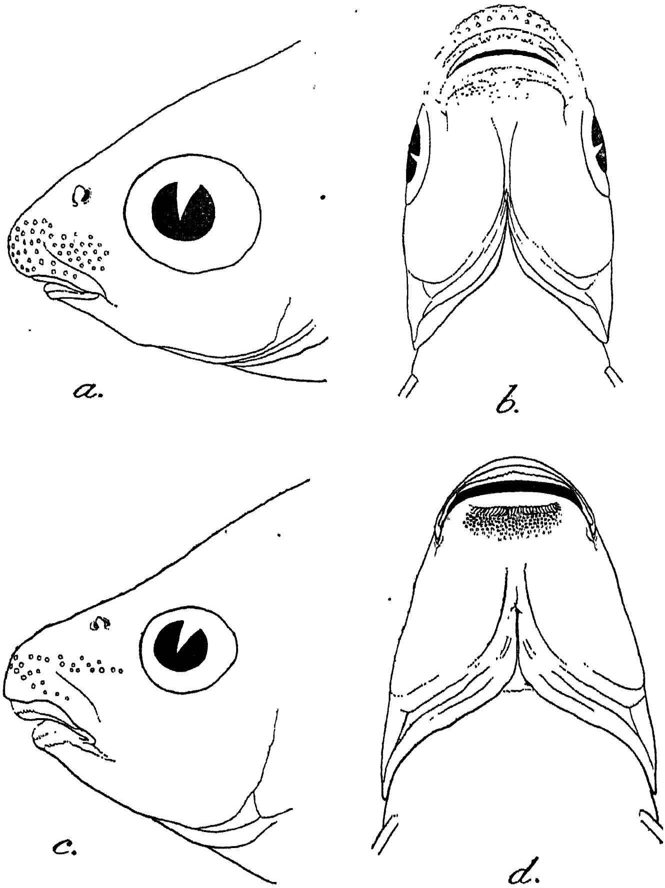
[1] Mukerji, D. D., *Journ. Bombay Nat. Hist. Soc.* XXXV, p. 169 (1931).
[2] Day, F., *Fish. India*, p. 552 (1877).
[3] Günther, A., *Cat. Fish. Brit. Mus.* VII, p. 40 (1868).
[4] Day, F., *Fish. India*, p. 545 (1877).

to this genus, but are referable to *Labeo* Cuvier. In fact, the two specimens of *O. chalybeatus* in the collection (Nos. 1527 and 1528) were,



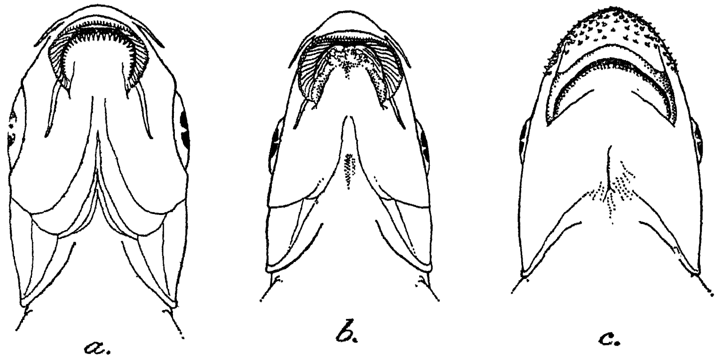
TEXT-FIG. 4.—*Osteochilus* (*Kantaka*) *brevidorsalis* (Day).

a. Lateral view of head of a young specimen from the Bhavani river: $\times 2\frac{2}{3}$; *b.* Ventral surface of head of same: $\times 2\frac{2}{3}$; *c.* Lateral view of head of an adult specimen from Mysore: $\times 1\frac{1}{6}$; *d.* Ventral surface of head of same: $\times 1\frac{1}{6}$.

entered in the Register on 21st May, 1879, as *Labeo*; they had been collected at Moulmein. One of these specimens (No. 1527) is probably the original of Day's description and figure, while the other has only 39 scales along the lateral line and 9 branched rays in the dorsal fin. The snout is covered with large well developed pores. This specimen seems to belong to *Labeo boga* (Hamilton). There are four specimens (Cat. Nos. 667-669) of *Osteochilus neilli* (Day) from Mandalay and Sittang but there is no specimen of *O. cephalus* (Cuv. & Val.). The last species was described by Cuvier and Valenciennes[1] as a *Labeo* and Vinciguerra[2] also showed that it is not referable to *Osteochilus*. It would thus appear

[1] Cuvier, G., and Valenciennes, A., *Hist. Nat. Poiss.* XVI, p. 374 (1842).
[2] Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 265 (1890).

that Day had only one species of *Osteochilus* from Burma which is very similar to the large number of species known from the East Indies. Since



TEXT-FIG. 5.—Ventral surface of head and anterior part of body of three species of *Osteochilus* Günther from Burma.

a. Osteochilus (*Osteochilus*) *neilli* Day: ×2⅓; *b. Osteochilus* (*Osteochilus*) *vittatus* (Cuv. & Val.): ×1⅓; *c. Osteochilus* (*Altigena*) *sondhii* Hora and Mukerji: ×1⅓.

then Mukerji[1] recorded *O. vittatus* (Cuv. & Val.) from the Mergui District, Lower Burma, and Mukerji and I[2] described *O. sondhii* from the Salween River at Takaw in the Kengtung State, Burma. The last species possesses only two short maxillary barbels and the lips are only slightly fimbriated, but the lower lip, though free, still covers the jaw and is finely striated along its entire inner surface.

In recent years several new species of *Osteochilus*, with considerable variation in structure and form, have been described from Southern China and Siam, and it appears that the genus is widely distributed in south-eastern Asia with its range extending as far west as Burma. Two attempts have been made to group the species into subgenera. Lin[3] in his account of the Chinese species of *Osteochilus* observed that:

> "The Chinese species of this genus show some notable variations from those of the Indo-Australian Archipelago and the mainland of India. The small, superior eye, and the striate or smooth upper lip of *O. tungting* and *O. brevis*, for example, are characters not known to be present in Indian species. But variations of this sort are quite common among the closely allied species of *Cyprinidae* and can not be of generic significance. In my description, therefore, I have taken the liberty to add these two characters and other small points to the original diagnosis of *Osteochilus* by Günther."

Lin recognised two sub-genera in the genus *Osteochilus*, which he defined as follows:—

A. Eye moderate or large, less than 5 in head; cheek narrow; skin of head not thickened. Lips thick, the upper one strongly striate, usually dilated laterally, continuous. Lower lip more or less papillate or fimbriate. Mandibular margin with transverse, hard, sharp, horny sheath. Barbels 4, or 2 maxillary ones only . . . *Osteochilus.*

AA. Eye small, its diameter more than 5½ in head, immediately below upper profile of head. Cheek deep. Skin of head thickened. Mouth distinctly inferior; lips thick, papillose, not fimbriate. Mandible with transverse, sharp horny edge. 2 minute maxillary barbels or none .. .. .. *Altigena.*

[1] Mukerji, D. D., *Rec. Ind. Mus.* XXXIV, p. 286 (1932).
[2] Hora, S. L., and Mukerji, D. D., *Rec. Ind. Mus.* XXXVI, p. 359 (1934).
[3] Lin, S. Y., *Lingnan Sci. Journ. Canton* XII, p. 340 (1933).

Fowler[1] distinguished two subgenera among the species from Siam and the East Indies, *Osteochilus* and *Neorohita*, on the size of scales (small, 45 to 55 in lateral line in *Osteochilus* while moderate or large, 30 to 40 in lateral line in *Neorohita*) and general physiognomy—the eyes being more elevated and snout short in *Neorohita*.

It will be clear from the above that though Day's three species of *Scaphiodon* from the Western Ghats cannot be assigned to *Osteochilus* Günther (*sensu stricto*), they are very closely related to *Altigena* Lin in the structure of the mouth and associated parts though the eyes are relatively much larger. Relying on the number of scales, their position would appear to be among *Neorohita* Fowler, but the structure of the mouth parts is very different. I am, therefore, obliged to separate them from the large number of species that have hitherto been described under *Osteochilus*. For the two species without an osseous ray in the dorsal fin, *Scaphiodon thomassi* and *S. nashii*, I propose the subgenus *Osteochilichthys* ; while for the unique species with a strong dorsal spine in the dorsal fin, *S. brevidorsalis*, *Kantaka*[2]. Of the species of *Osteochilus* known from Burma, *O. neilli* Day, with 34 scales along the lateral line, four barbels, fimbriated lips and eye $3\frac{1}{2}$ times in length of head is referable to the subgenus *Osteochilus* Lin. *O. vittatus* (Cuv. & Val.), with 33-34 scales along the lateral line, four barbels, fimbriated lips and eye 3-4 times in length of head also pertains to the same subgenus. As regards general physiognomy, however, *O. neilli* is allied to *O. melanopleura* (Bleeker), the type of Fowler's subgenus *Osteochilus*, though its scales are of a moderate size. The third Burmese species, *O. sondhii* possesses 39-40 scales along the lateral line, two short maxillary barbels which are hidden in deep grooves, lips are slightly fimbriated or papillated (the lower lip, though free from the jaw, covers it entirely) and the eye is contained from 3·5—3·9 times in the length of the head. On the number of scales, therefore, all the three Burmese species should be included in the subgenus *Neorohita* Fowler, which is the commonest type in south-eastern Asia. It seems, however, that the species of *Osteochilus* from Southern China, Indo-China, Siam, Malay Peninsula and the Indo-Australian Archipelago are greatly in need of revision and regrouping.

Genus **Osteochilus** Günther.

Subgenus **Osteochilichthys**, nov.

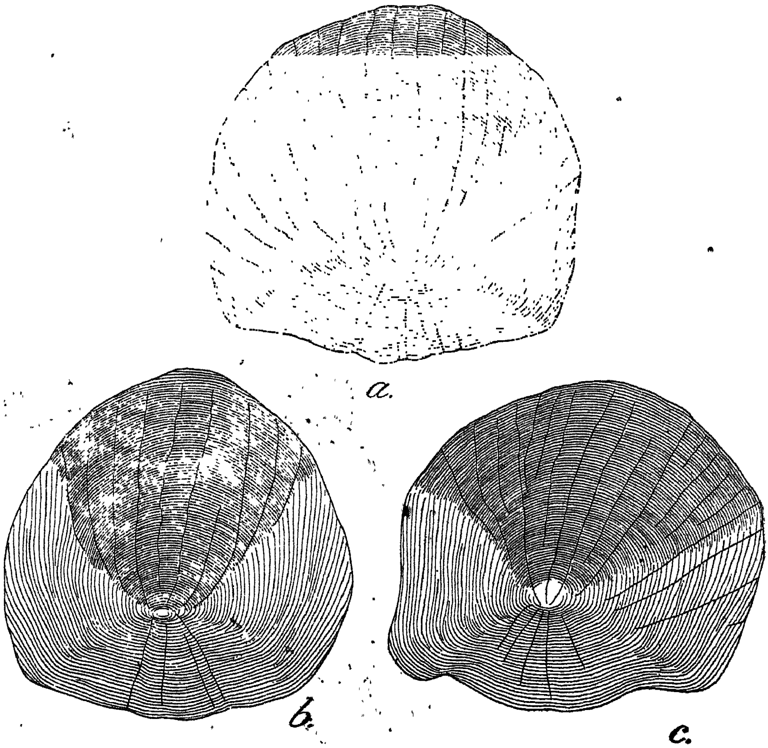
The members of this subgenus differ from the other subgenera of *Osteochilus* in having the lower lip attached to the lower jaw at some distance from the mouth, with the result that the lower jaw is not covered by the lip as is also the case in *Scaphiodon* Heckel. The eye is of a moderate size ($3\text{-}4\frac{1}{3}$ in length of head) and the number of scales along the lateral line varies from 39 to 4?

[1] Fowler, H. W., *Proc. Acad. Nat. Sci. Philad.* LXXXIX, p. 179 (1937).

[2] Derived from a Sanskrit word meaning spine

Type-species.—*Scaphiodon thomassi* Day.

The other species referable to *Osteochilichthys* is *S. nashii* (Day). Though agreeing in lepidosis and number of fin-rays, the two species



Text-fig. 6.—Scales from below base of dorsal fin of species of *Osteochilus* from Peninsular India.

a. Osteochilus (*Kantaka*) *brevidorsalis* (Day), young specimen: × 12½; *b. Osteochilus* (*Osteochilichthys*) *thomassi* (Day): × 15; *c. Osteochilus* (*Osteochilichthys*) *nashii* (Day): × 12½.

differ in their respective relative depth of the body and the structure of the mouth and associated parts as indicated above.

Subgenus **Kantaka,** nov.

This subgenus is proposed for *Scaphiodon brevidorsalis* (Day). It is closely allied to *Osteochilichthys* described above, but differs from it in the possession of a very strong osseous dorsal spine. So far as I am aware, this is the only species of *Osteochilus* in which the dorsal spine is osseous and strong.

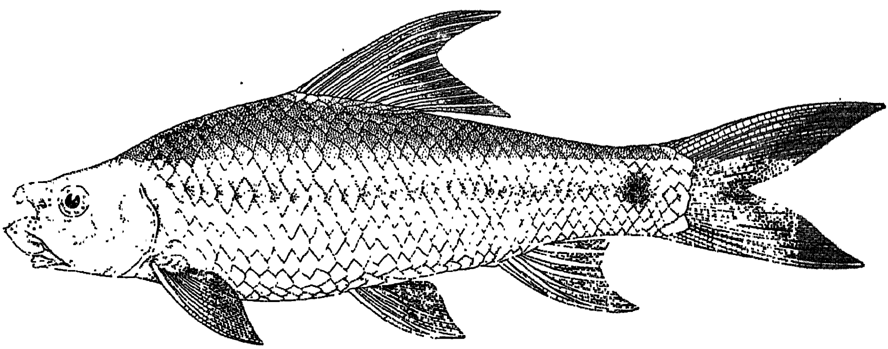
Type-species.—*Semiplotus brevidorsalis* Day.

Measurements in millimetres, scale-counts and fin-rays of Osteochilus (Osteochilichthys) thomassi *(Day)*, O. (Osteochilichthys) nashii *(Day) and* O. (Kantaka) brevidorsalis *(Day)*.

	O. thomassi.			*O. nashii.*				*O. brevidorsalis.*	
Total length	166	143+C.	82	141	104	95	92	264	103
Length of caudal ..	33	—	20	29	23	22	19	63	29
Depth of body ..	47	56	24	35	26	21	20	77	25
Length of head ..	31	33	16	26	19	18	17	43	18
Width of head ..	18	22	10	16	12	11	10	32	11
Height of head ..	26	28	13	19	16	14	14	41	15
Diameter of eye ..	9	10	5	7	6	6	6	11	7
Interorbital distance	12	17	7	11	8	7	7	23	8
Length of caudal peduncle.	19	21	9	18	12	11	12	32	11
Least height of caudal peduncle.	16	20	8	14	10	9	9	26	10
Scales along lateral line	40	39	40	43	41	41	41	40	41
Transverse rows of scales.	13	12	14	14	13	14	14	14	14
No. of predorsal scales	13	13	13	14	13	13	13	12	12
No. of rows of scales between L. l. and V.	5	4½	5	5	5	5	5	5	5
No. of rays in dorsal ..	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/12	4/11
No. of rays in pectoral	14	14	14	14	14	14	14	14	14
No. of rays in ventral	9	9	9	9	9	9	9	9	9
No. of rays in anal ..	2/6	3/6	3/6	3/5	3/5	3/6	3/5	3/6	3/5
No. of rays in caudal ..	19	19	19	19	19	19	19	19	19

XLIII. ON THE SYSTEMATIC POSITION OF *CYPRINUS NUKTA* SYKES.

In describing his *Cyprinus nukta* from the Inderanee river, 18 miles north of Poona, Sykes[1] stated that the character of its head—" with

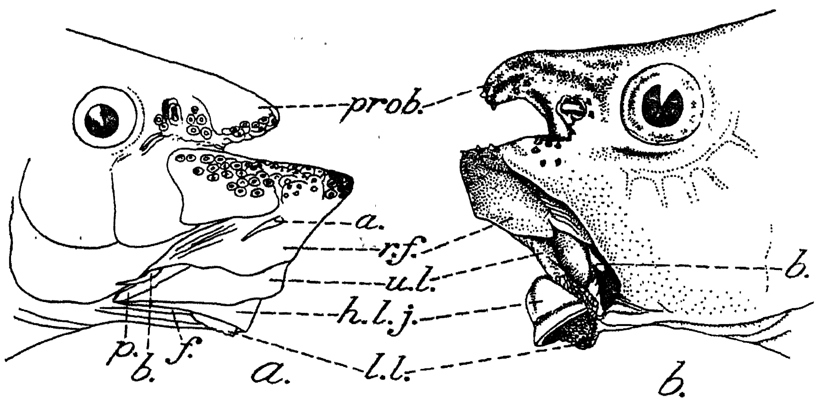


TEXT-FIG. 7.—Lateral view of *Schismatorhynchus* (*Nukta*) *nukta* (Sykes) : $\times \frac{1}{2}$.

two short horns or bosses on the space between the eyes "—is sufficient to distinguish it from all other species of *Cyprinus*. According to him, both Rüppell and Yarrell, after examining the fish, pronounced it as " a monstrosity of *C. auratus* ". Sykes, however, found it very common in the Deccan and the local people recognised it as a distinct kind and called it by the specific name *Nukta*, in which reference is made to the

[1] Sykes, W. H., *Trans. Zool. Soc. London* II, p. 325 (1841).

fist-shaped proboscis on the snout. Jerdon[1] referred to it with a query, but Günther[2] included it definitely under the synonymy of *Carassius auratus*. Day,[3] after examining two specimens from Poona, 10 and 12 inches respectively in length, included the species under *Labeo* Cuvier and gave a complete account of the fish. With regard to the structure of the head he observed, "*Head* compressed, snout projecting over the mouth and having a deep groove passing from one orbit to the opposite one, thus occasioning the appearance as if there were a blunt compressed knob, between and before the orbits". When further material became available to Day[4] from "the rivers of the Deccan", he emended his first description to a certain extent. In the *Fauna* he[5] gave two Marathi names of the species, *Nakta* and *Naktashendva*. A reference to the literature shows that this remarkable character in *Labeo*-like fishes is shared by only one other species, *Schismatorhynchus heterorhynchus* (Bleeker), for which Bleeker[6] had proposed a distinct



TEXT-FIG. 8.—Lateral view of head of two species of *Schismatorhynchus* Bleeker.

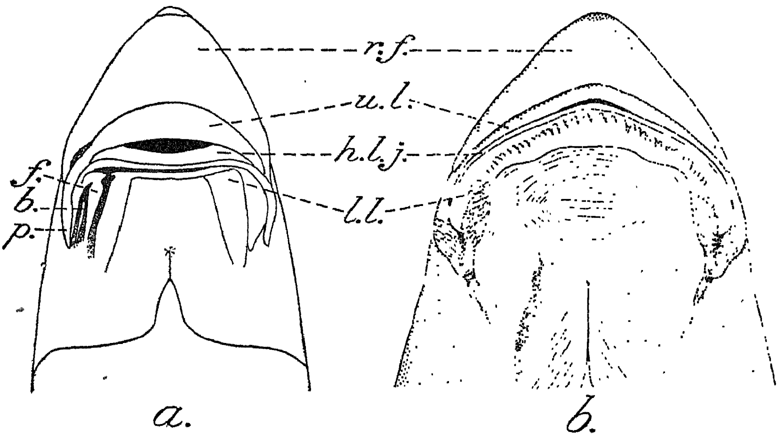
a. Schismatorhynchus (*Schismatorhynchus*) *heterorhynchus* (Blkr.) : × Nat. Size. After Weber and de Beaufort; *b. Schismatorhynchus* (*Nukta*) *nukta* (Sykes) : × 1⅓.

a. rostral barbel; *b.*, maxillary barbel; *f.*, frenulum; *h. l. j.*, horny layer of lower jaw; *l. l.*, lower lip; *p.*, prolongation of the lip; *prob.*, proboscis; *r. f.*, rostral fold; *u. l.*, upper lip.

genus, though Günther[7] and later authors included it under *Tylognathus* Heckel or *Labeo* Cuvier. Weber and de Beaufort[8] have recognised Bleeker's genus as valid and in giving its distribution noted "Fresh water of Indo-Australian Archipelago (Sumatra and Borneo); perhaps also represented on the Indian continent". Presumably the authors had in mind *Labeo nukta* (Sykes), for no other species of *Labeo* on the Indian mainland possesses a proboscis on the snout.

[1] Jerdon, T. C., *Madras Journ. Litt. Sci.* XV, p. 303 (1849).
[2] Günther, A., *Cat. Fish. Brit. Mus.* VII, p. 32 (1868).
[3] Day, F., *Journ. As. Soc. Bengal* XLI, p. 319 (1872).
[4] Day, F., *Fish. India*, p. 543 (1877).
[5] Day, F., *Faun. Brit. Ind.* Fish I, p. 270 (1889).
[6] Bleeker, P., *Nat. Tijdschr. Ned. Ind.* IX, pp. 258, 269 (1855).
[7] Günther, A., *loc. cit.*, p. 67 (1868).
[8] Weber, M. and de Beaufort, L. F., *Fish. Indo-Austral. Archipel.* III, p. 216 (1916).

There is undoubtedly a great similarity between the Indo-Australian species *Schismatorhynchus heterorhynchus* and the Deccan form *Labeo nukta*, but when the specimens of the latter are compared with Weber



TEXT-FIG. 9.—Ventral surface of head in two species of *Schismatorhynchus* Bleeker.

a. Schismatorhynchus (*Schismatorhynchus*) *heterorhynchus* (Blkr.). Nat. Size, After Weber and de Beaufort; *b. Schismatorhynchus* (*Nukta*) *nukta* (Sykes): ×2.

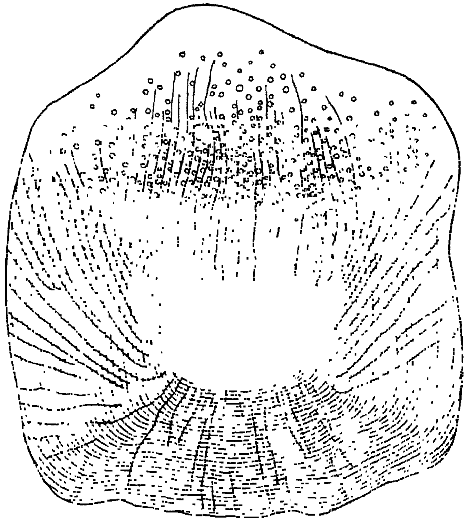
b., maxillary barbel; *f.*, frenulum; *h. l. j.*, horny layer of lower jaw; *l. l.*, lower lip; *p.*, prolongation of jaw; *r. f.*, rostral fold; *u. l.*, upper lip.

and de Beaufort's description of the former the following points of difference may be noted:

Schismatorhynchus heterorhynchus.	*Labeo nukta.*
1. Lower part of snout much longer and more prominent than the upper.	Lower part of snout generally longer than the upper, but, though more prominent, may be equal to it.
2. Corner of mouth prolonged as a kind of gutter.	Corner of mouth not prolonged.
3. Lower lip reflected, not continuous with the upper lip.	Lower lip reflected, inner surface studded with large papillae, continuous with upper lip.
4. Lower lip separated from the posterior prolongation of the soft covering of the jaw by a longitudinal postlabial groove, which is divided by a longitudinal fleshy frenulum in a median and a lateral part, the last of which contains the maxillary barbel and the gutter-like prolongation.	Labial groove restricted to the corners of the mouth and contains flaplike, crenulated, small maxillary barbels. No longitudinal grooves continuous with the labial groove run backwards from the angles of the mouth.
5. Pair of rostral barbels.	Rostral barbels absent.

The differences noted above in the structure of the lips and associated parts are of sufficient value to separate the two species generically, but I wish at the same time to stress, particularly from a zoogeographical point of view, the great general similarity in the form and structure of the two species and have accordingly divided the genus *Schismatorhynchus* into two subgenera, *Schismatorhynchus* for *S. heterorhynchus*

and *Nukta,* subgenus nov., for *Cyprinus nukta* Sykes. (Type-species for the subgenus *Nukta* is *Cyprinus nukta* Sykes.) The distinguishing



TEXT-FIG. 10.—A scale of *Schismatorhynchus* (*Nukta*) *nukta* (Sykes) from below base of dorsal fin : × 6.

characters of these two subgenera are given in the table above. In the three specimens of *S.* (*Nukta*) *nukta* that I have examined, the extent of the proboscis varies considerably. As sufficient material of the species is not available, I give below a table of measurements, scale-counts and fin-rays to facilitate reference in future.

Measurements in millimetres, scale-counts and fin-rays of Schismatorhynchus (Nukta) nukta (*Sykes*).

Total length	224	296	299
Length of caudal	54	66	72
Depth of body	56	67	73
Length of head	41	46	45
Width of head	28	31	32
Height of head	35	40	41
Length of proboscis from anterior margin of orbit ..	15	17	13
Diameter of eye	9	9	9
Interorbital distance	18	20	21
Length of caudal peduncle	26	31	30
Least height of caudal peduncle	24	31	32
Scales along lateral line	38	37	37
Transverse rows of scales	14	15	14
No. of predorsal scales	15	14	14
No. of rows of scales between L. l. and V.	5	5	5
No. of rays in dorsal	3/9	2/9	3/8
No. of rays in pectoral	1/15	1/13	1/13
No. of rays in ventral	9	9	9
No. of rays in anal	2/5	2/5	2/5
No. of rays in caudal	19	19	19

ZOOGEOGRAPHICAL REMARKS.

The great significance of the taxonomic findings reported above lies in the fact that further valuable evidence has become available to stress the Malayan affinities[1] of the fish fauna of Peninsular India; the distribution of *Osteochilus* is at par with that of the Homalopteridae[2], *Silurus*,[3] *Batasio*,[4] *Thynnichthys*, etc. All of these fishes are widely represented in the fauna of south-eastern Asia, but a few forms are also found in Peninsular India in the Western Ghats or the hill ranges associated with them. The distribution of *Schismatorhynchus* is still more remarkable; it is represented by one species in Sumatra and Borneo, Malay Archipelago, and by a second species, subgenerically distinct, in Peninsular India. It is remarkable that though a number of the Malayan Cyprinoid genera have undergone structural changes as a result of their long isolation in Peninsular India and have proliferated into new genera or subgenera the typically Malayan catfishes of Peninsular India, such as *Silurus* and *Batasio*, have not shown any marked change from their respective ancestral stock in the Far East.

[1] Hora, S. L. and Law, N. C., *Rec. Ind. Mus.* XLIII, p. 242 (1941).
[2] Hora, S. L., *Rec. Ind. Mus.* XLIII, p. 222 (1941).
[3] Bhimachar, B. S. and Subba Rau, A., *Journ. Mysore Univ.* (B) I, p. 147 (1941).
[4] Hora, S. L. and Law, N. C., *loc. cit.* XLIII, p. 28 (1941).

RECORDS

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INDIAN MUSEUM

Vol. XLIV, Part II, pp. 193—200

A list of Fishes of the Mysore State and of the neighbouring Hill ranges of the Nilgiris, Wynaad and Coorg.

SUNDER LAL HORA

CALCUTTA:
AUGUST, 1942

A LIST OF FISHES OF THE MYSORE STATE AND OF THE NEIGHBOURING HILL RANGES OF THE NILGIRIS, WYNAAD AND COORG.

By SUNDER LAL HORA, *D.Sc.*, *F.R.S.E.*, *F.N.I.*, *Assistant Superintendent, Zoological Survey of India, Calcutta.*

In a recent article entitled "The Fishes of Mysore State", Bhimachar and Subba Rau[1] have given an account of the fishes of the Kadur District and have briefly referred to the earlier works on the ichthyology of this part of the Deccan plateau. A general account of the physical features of the State is given and remarks are offered on the zoogeographical significance of the occurrence in Mysore of certain Malayan species. The authors propose to make a detailed systematic study of the fishes found in different parts of the State and the results are to be published from time to time as and when the reports are ready.

The authors have published valuable observations on *Silurus cochinchinensis* Cuvier & Valenciennes; it is a very variable, loach-like Silurid which lives at the bottom of shallow, rocky streams and is widely distributed from Cochin-China, Southern China, Siam, Malay Peninsula, Burma, Assam Hills, Eastern Himalayas, Mysore and the Wynaad Hills. In recording this species from Mysore for the first time, the authors have adduced evidence to show that *S. wynaadensis* Day, a species which was distinguished by the presence of 4 barbles, is the same as *S. cochinchinensis*, normally with two barbles in the adult state.

With a view to help in the survey of the fish-fauna of the State, I give below a systematic list of the species so far known from Mysore and the adjoining hill-ranges of the Nilgiris, Wynaad and Coorg, along with their respective areas of distribution.

LIST[2] OF THE FISHES OF MYSORE AND OF THE ADJOINING HILL RANGES.

The general classification of fishes adopted in the list is that proposed by Dr. C. Tate Regan, F.R.S., in his article on 'Fishes' in the

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[1] Bhimachar, B. S. and Subba Rau, A. *Journ. Mysore Univ.* (B) I, pp. 141-153, 1 map, 1 text-fig. and 2 pls. (1941).

[2] In drawing up this list, recent records of fishes from Mysore have been consulted as well as Day's *Fishes of India* and his two volumes on 'Fishes' in the *Fauna of British India* series. The enumeration of species is, however, not based on actual examination of specimens.

In connection with the geographical distribution of the various species, the following works were consulted:—1. Suvatti, C., *Index to Fishes of Siam*, (Bangkok, 1936); 2. Fowler, H. W., 'A List of Fishes known from Malaya.' *Fisheries Bull. Singapore*, No. 1 (1938); 3. Weber, M. and Beaufort L. F. de, *The Fishes of the Indo-Australian Archipelago* (Leiden, 1913-1936); 4. Chu, Y. T., 'Index Piscium Sinensium.' *Biol. Bull. St. John's Univ.* No. 1 (1931); 5. Chabanaud, P., 'Inventaire de la faune ichtyologique de l'Indochine. Premiere Liste.' *Service Oceanographique des peches de l'Indochine*, Note 1 (1926); and 6. Chevey, P., 'Inventaire de la faune ichtyologique de l'Indochine. Deuxieme Liste.' *Inst. Oceanographique de l'Indochine*, Note 19. (1932).

Fourteenth Edition of the Encyclopaedia Britannica (1929). The genera under their respective families and the species under each genus are alphabetically arranged.

Names of Species.	*Geographical Range.*
Order : ISOSPONDYLI.	
Family : NOTOPTERIDAE.	
1. *Notopterus notopterus* (Pallas) ..	India, Burma and further east.
Family : CLUPEIDAE.	
2. *Hilsa ilisha* (Ham.)	Persian Gulf and coasts of India and Burma ; it ascends principal rivers.
Order : OSTARIOPHYSI.	
Suborder : *CYPRINOIDEA.*	
Family : CYPRINIDAE.	
Subfamily : *ABRAMADINAE.*	
3. *Chela argentea* Day ..	Nilgiris, Coorg and Mysore. Also found at Calcutta.
4. *Chela baicala* Ham. ..	Throughout India (except Malabar), and Burma.
5. *Chela clupeoides* (Bloch)	Cutch, Peninsular India and Satpura Trend.
6. *Chela phulo* Ham. ..	Assam, Bengal, Orissa, Central Provinces and the Deccan as far as the Kistna.
7. *Laubuca atpar* (Ham.)	India and Burma.
Subfamily : *RASBORINAE.*	
8. *Barilius barila* Ham. ..	Northern India as far as the Kistna and Burma.
9. *Barilius barna* Ham. ..	Northern India as far as the Kistna and Burma.
10. *Barilius bendelisis* Ham.	Throughout India. Day's records from Ceylon requires confirmation.
11. *Barilius canarensis* (Jerd.)	Western Ghats of Malabar, Canara and Mysore.
12. *Barilius gatensis* (C. V.)	Western Ghats of Malabar, Nilgiris, Coorg, Mysore and Travancore.
13. *Barilius vagra* Ham. ..	Northern India as far as the Kistna. Day's record from Ceylon requires confirmation.
14. *Brachydanio rerio* (Ham.)	India and Burma.
15. *Danio aequipinnatus* (McClell.)[1]	Ceylon, India, Burma and Siam.
16. *Esomus barbatus* (Jerd.) ..	Peninsular India.
17. *Rasbora caverii* (Jerd.)	Coorg and Mysore State.
18. *Rasbora daniconius* (Ham.)	Ceylon, India, Burma and further east.
19. *Rasbora rasbora* (Ham.)	India, Burma and further east.
Subfamily: *CYPRININAE.*	
20. *Amblypharyngodon melettina* (C. V.)	Ceylon and Peninsular India.
21. *Amblypharyngodon microlepis* (C. V.)	Peninsular India, through Orissa to Calcutta.
22. *Amblypharyngodon mola* (Ham.)	India, except Malabar, and Burma.
23. *Barbus (Puntius) amphibius* (C. V.)	Ceylon and Peninsular India.

[1] Hora and Nair have recently shown (*Rec. Ind. Mus.* XLIII, p. 371, 1941) that *Danio strigillifer* Myers and *D. malabaricus* (Jerdon) are synonymous with *D. aequipinnatus* (McClelland).

Names of Species.	*Geographical Range.*
24. *Barbus (Puntius) carnaticus* (Jerd.)	Nilgiris, Wynaad, Mysore and S. Canara.
25. *Barbus (Puntius) chola* Ham.	India, Burma and further east.
26. *Barbus (Puntius) dorsalis* (Jerd.)[1]	Peninsular India and Ceylon.
27. *Barbus (Puntius) dubius* Day ..	Nilgiris and Mysore.
28. *Barbus (Puntius) filamentosus* (C. V.)[2]	Ceylon and Peninsular India.
29. *Barbus (Puntius) jerdoni* Day[3]	Deccan and Canara below the Ghats; its record from Malaya needs confirmation.
30. *Barbus (Puntius) kolus* Sykes..	Deccan and Central Provinces.
31. *Barbus (Puntius) lithopidos* Day	Coorg, Mysore, S. Canara and Travancore.
32. *Barbus (Puntius) melanampyx* (Day)	Peninsular India.
33. *Barbus (Puntius) micropogon* C. V.	Nilgiris, Wynaad, Mysore, S. Canara and Travancore.
34. *Barbus (Puntius) narayani* Hora	Coorg and Mysore.
35. *Barbus (Puntius) neilli* Day ..	Mysore and Deccan. Its record from Malaya needs confirmation.
36. *Barbus (Puntius) parrah* (Day)	Peninsular India.
37. *Barbus (Puntius) pleurotaenia* Blkr.	Ceylon and Mysore.
38. *Barbus (Puntius) pulchellus* Day	Mysore.
39. *Barbus (Puntius) sarana* (Ham.)[5]	Ceylon, India and Burma. It has also been recorded from China.
40. *Barbus (Puntius) sophore* Ham.[6]	India, Burma and Yunnan.
41. *Barbus (Puntius) ticto* Ham.[7]	Ceylon, India, Burma and Siam.
42. *Barbus (Puntius) vittatus* (Day)	Cutch, Peninsular India and Ceylon.
43. *Barbus (Tor) khudree* Sykes[4] ..	Ceylon, Peninsular India, Deccan and Satpura Trend.
44. *Catla catla* (Ham.) ..	Northern India as far as the Kistna and Burma. Introduced into the Cauvery.
45. *Cirrhina cirrhosa* (Bloch)	Southern India generally.
46. *Cirrhina fulungee* (Sykes)	Deccan and Mysore.

[1] *Puntius puckelli* Day is a synonym of *Puntius dorsalis* (Jerdon); *vide* Hora, S. L., *Rec. Ind. Mus.* XXXVIII, p. 2 (1936).

[2] *Barbus (Puntius) mahecola* (C. V.) is the female of *B. (Puntius) filamentosus* (C. V.); *vide* Hora, S. L., *Rec. Ind. Mus.* XXXIX, pp. 22-24 (1937).

[3] *Barbus Dobsoni* Day (*Fish. India*, p. 568, 1878) is a synonym of *B. jerdoni* Day.

[4] For a description of *Barbus khudree* Sykes see Hora and Misra in *Journ. Bombay Nat. Hist. Soc.* XL, pp. 24-28 (1938). Taxonomy of this species will be discussed in my series of articles on the "Game Fishes of India".

[5] *Barbus chrysopoma* C.V. and *B. pinnauratus* (Day) are synonyms of *Barbus sarana* (Ham.).

[6] *Barbus (Puntius) stigma* (Cuv. & Val.) of authors is synonymous with *B. (Puntius) sophore* Ham.; *vide* Chaudhuri, *Mem. Ind. Mus.* V, p. 436 (1916).

[7] *Barbus punctatus* Day from Peninsular India and *B. stoliczkanus* Day from Burma characterised by the presence of a complete lateral line are synonymous with *B. ticto*; *vide* Hora, Misra and Malik, *Rec. Ind. Mus.* XLI, p. 263 (1939).

Names of Species.	*Geographical Range.*
47. *Cirrhina reba* (Ham.) ..	Throughout India. Its record from Indo-china requires confirmation.
48. *Garra bicornuta* Rao ..	Mysore.
49. *Garra jerdoni* Day ..	Nilgiris, Wynaad and Mysore.
50. *Garra mullya* (Sykes) ..	Kathiawar, Peninsular India and Satpura Trend.
51. *Garra stenorhynchus* (Jerd.)	Nilgiris, Coorg and Mysore.
52. *Labeo ariza* (Ham.) ..	Nilgiris, Wynaad and Mysore.
53. *Labeo boga* (Ham.) ..	India and Burma.
54. *Labeo boggut* (Sykes) ..	Central and south-west India. Its record from Malaya requires confirmation.
55. *Labeo calbasu* (Ham.) ..	India and Burma. It has been recorded from China also.
56. *Labeo dussumieri* (C. V.)	Ceylon, South Malabar and Mysore.
57. *Labeo fimbriatus* (Bloch)	Sind, Punjab, the Deccan and Southern India to Orissa. Not recorded from Malabar.
58. *Labeo kawrus* (Sykes)	Poona and the Deccan.
59. *Labeo kontius* (Jerd.)	Nilgiris and Mysore.
60. *Labeo potail* (Sykes)	Mysore, Deccan and Ceylon.
61. *Mystacoleucus ogilbii* (Sykes)	Mysore and Deccan.
62. *Oreichthys cosuatus* (Ham.) ..	India, Burma and Siam.
63. *Osteochilus* (*Kantaka*) *brevidorsalis* (Day)	Nilgiris and Mysore.
64. *Osteochilus* (*Osteochilichthys*) *nashii* (Day)	Coorg, Wynaad, S. Canara and Mysore.
65. *Osteochilus* (*Osteochilichthys*) *thomassi* (Day)	South Canara and Mysore.
66. *Rohtee cotio* var. *cunma* Day ..	Sind, Deccan, Orissa, Assam and Burma.
67. *Rohtee neilli* Day	Deccan, Mysore and Travancore.
68. *Schismatorhynchus* (*Nukta*) *nukta* (Sykes)	Mysore and Deccan.
Family : HOMALOPTERIDAE.	
69. *Bhavania australis* (Jerd.)[1] ..	Malabar, Wynaad, Nilgiris, Mysore and Travancore.
70. *Balitora brucei* var. *mysorensis* Hora	Mysore.
Family : COBITIDAE.	
71. *Botia striata* Rao	Mysore.
72. *Lepidocephalus thermalis* (C. V.)	Ceylon and Peninsular India.
73. *Nemachilichthys shimogensis* Rao	Mysore.
74. *Nemachilus anguilla* (Annan.)	Yenna River at Mehda, Satara Dist., and Thunga River at Shimoga, Mysore.
75. *Nemachilus bhimachari* Hora	Mysore.
76. *Nemachilus botia* (Ham.) ..	Ceylon, India and Burma.
77. *Nemachilus dayi* Hora ..	Deccan and the Satpura Trend.
78. *Nemachilus denisonii* Day ..	Deccan, Nilgiris, Coorg and Mysore.
79. *Nemachilus evezardi* Day ..	Deccan, Satpura Trend and Peninsular India.
80. *Nemachilus monilis* Hora ..	Nilgiris and Mysore.
81. *Nemachilus semiarmatus* Day ..	Nilgiris and Mysore.
82. *Nemachilus sinuatus* Day ..	Wynaad and Mysore.
83. *Nemachilus striatus* Day ..	Wynaad, Nilgiris and Mysore.

[1] *Bhavania annandalei* Hora is synonymous with *B. australis* (Jerdon); *vide* Hora, *Rec. Ind. Mus.* XLIII, p. 225 (1941).

Names of Species.	*Geographical Range.*
Suborder : *SILUROIDEA.*	
Family : CLARIIDAE.	
84. *Clarias batrachus* (Linn.) ..	India, Burma and further east.
Family : HETEROPNEUSTIDAE.	
85. *Heteropneustes fossilis* (Bloch)	Ceylon, India, Burma and further east.
Family : SILURIDAE.	
86. *Callichrous bimaculatus* (Bloch)	Ceylon, India, Burma and further east.
87. *Silurus cochinchinensis* C. V. ..	Wynaad, Mysore, Eastern Himalayas, Assan Hills, Burma and further east.
88. *Wallagonia attu* (Bloch) ..	Ceylon, India, Burma and further east.
Family : SCHILBEIDAE.	
89. *Proeutropiichthys taakree* (Sykes)[1]	Peninsular India, except Malabar.
90. *Pseudeutropius atherinoides* (Bloch)	India and Burma.
91. *Silonopangasius childrenii* (Sykes)	Deccan Western Ghats near Poona to Mysore.
Family : BAGRIDAE.	
92. *Mystus aor* (Ham.)	India, Burma and China.
93. *Mystus cavasius* (Ham.) ..	India, Burma and further east.
94. *Mystus keletius* (C. V.) ..	Ceylon and Peninsular India.
95. *Mystus malabaricus* (Jerd.) ..	Wynaad, Mysore, Malabar and Travancore.
96. *Mystus montanus* (Jerd.) ..	Wynaad, Coorg, Mysore and Travancore.
97. *Mystus oculatus* (C. V.) ..	Nilgiris, Mysore, Malabar and Travancore.
98. *Mystus punctatus* (Jerd.) ..	Nilgiris and Mysore.
99. *Mystus vittatus* (Bloch) ..	Ceylon, India, Burma and Siam.
100. *Rita hastata* Val.	Deccan and Mysore.
Family : SISORIDAE.	
101. *Bagarius bagarius* (Ham.) ..	India, Burma and further east.
102. *Gagata itchkeea* (Sykes) ..	Northern parts of Western Ghats and Coorg.
103. *Glyptothorax lonah* (Sykes) ..	Deccan and the Satpura Trend.
104. *Glyptothorax madraspatanus* (Day)	Nilgiris, Mysore and Travancore.
Order : APODES.	
Family : ANGUILLIDAE.	
105. *Anguilla bengalensis* Gray ..	Ceylon, India, Burma and further east.
Order : SYNENTOGNATHI.	
Suborder : *SCOMBRESOCOIDEA.*	
Family : XENENTODONTIDAE.	
106. *Xenentodon cancila* (Ham.) ..	Ceylon, India, Burma and further east.
Order : MICROCYPRINI.	
Family : CYPRINODONTIDAE.	
107. *Aplocheilus blockii* (Arnold) ..	Ceylon and Peninsular India.
108. *Aplocheilus lineatus* (C. V.) ..	Ceylon and Peninsular India.
109. *Oryzias melanostigma* (McClell.)	Peninsular India, Orissa, Lower Bengal and Burma.

[1] *Schilbe sykesii* Jerdon, *Eutropius microphthalmus* Blyth, *Pseudeutropius megalops* Günther and *P. longimanus* Günther are synonymous with *Proeutropiichthys taakree* Sykes; *vide* Hora, *Rec. Ind. Mus.* XLIII, p. 106 (1941).

Names of Species.	*Geographical Range.*
Order : PERCOMORPHI.	
Suborder : *PERCOIDEA.*	
Family : AMBASSIDAE.	
110. *Ambassis nama* (Ham.)	India and Burma.
111. *Ambassis ranga* (Ham.)	India, Burma and further east.
Family : CICHLIDAE.	
112. *Etroplus suratensis* (Bloch)	Ceylon and Peninsular India.
Suborder : *GOBIOIDEA.*	
Family : GOBIIDAE.	
113. *Glossogobius giuris* (Ham.)	Ceylon, India, Burma and further east.
Suborder : *ANABANTOIDEA.*	
Family : POLYCANTHIDAE.	
114. *Macropodus cupanus* C. V.	South India, Malay Peninsula and Sumatra.
Suborder : *OPHICEPHALOIDEA.*	
Family : OPHICEPHALIDAE.	
115. *Ophicephalus gachua* Ham. ..	Ceylon, India, Burma and further east.
116. *Ophicephalus leucopunctatus* Sykes	Peninsular India and Deccan.
117. *Ophicephalus marulius* Ham.	Ceylon, India, Burma and further east.
118. *Ophicephalus punctatus* Bloch	India, Burma and Malaya.
119. *Ophicephalus striatus* Bloch ..	Ceylon, India, Burma and further east.
Order : OPISTHOMI.	
Family : MASTACEMBELIDAE.	
120. *Mastacembelus armatus* (Lacép.)	Ceylon, India, Burma and further east.
121. *Mastacembelus pancalus* (Ham.)	Northern India generally : its records from south of Kistna are few.

It will be seen from the above that in the fish fauna of Mysore and the neighbouring tracts there is a great preponderance of the Ostariophysi. Of the 121 species listed above, as many as 102 belong to this order (81 to the Suborder Cyprinoidea and 21 to the Siluroidea). Out of the 81 Cyprinoid fishes, there are 15 species of loaches, 2 belonging to the family Homalopteridae and 13 to the Cobitidae, and 66 true Carp or Cyprinidae. Of the remaining 19 species, 1 belongs to the Apodes (Anguillidae), 1 to the Synentognathi (Xenentodontidae), 3 to the Microcyprini (Cyprinodontidae), 10 to the Percomorphi (Ambassidae 2, Cichlidae 1, Gobiidae 1, Polycanthidae 1 and Ophicephalidae 5) and 2 to the Opisthomi. The Percomorphi are rather poorly represented in the above list and it is surprising that even some of the widely distributed species do not appear to have been recorded from this region. It seems certain that when a detailed fish survey of the State is completed many more species will be added to its fauna.

ZOOGEOGRAPHICAL REMARKS ON THE FISH-FAUNA OF MYSORE.

As regards physical features, the Mysore State has been broadly divided into two areas, the Maidan and the Malnad. The former comprises the eastern part of the State ; it is a plain, cultivated country with a gentle slope towards the east. According to Blanford[1], the

[1] Blanford, W. T. *Phil. Trans. Roy. Soc. London* (B), CXCIV, p. 346 (1901).

Maidan area of Mysore is included in the Carnatic or Madras zoogeographical tract which is defined as follows :—

> "The Peninsula south of the Kistna or of 16°N. lat.,[1] and east of the Western Ghats, comprising the Carnatic and Mysore. The plains of the Carnatic are much like those of the Deccan and are for the most part cleared, but there are scattered hill groups, generally covered with forest and with a much higher rainfall than the plains. The average temperature is slightly higher than that of the Deccan, but more equable, the average annual range of the thermometer being considerably smaller. The average rainfall is about 35 inches."

Blanford recorded the occurrence of the following genera of fresh-water fishes from the Carnatic Tract :

Symbranchus.
Anguilla.
Clarias.
Saccobranchus (=*Heteropneustes*).
Wallago (=*Wallagonia*).
Callichrons.
Ailia.
Pseudeutropius.
Pangasius.
Silundia (=*Silonia*).
Macrones (=*Mystus*).
Rita.
Bagarius.
Glyptosternum (=*Glyptothorax*).
Chela.
Notopterus.
Ambassis.
Gobius.
Lepidocephalichthys (=*Lepidocephalus*).
Jerdonia.
Nemachilus.
Discognathus (=*Garra*).
Labeo.
Cirrhina.
Amblypharyngodon.
Barbus.
Nuria (=*Esomus*).
Rasbora.
Rohtee.
Barilius.
Danio.
Perilampus (=*Laubuca*).
Mastacembelus.
Ophicephalus.
Anabas.
Polyacanthus.
Etroplus.

Of the genera enumerated above, *Jerdonia* is endemic in this tract, *Polyacanthus* and *Etroplus* are found in Peninsular India and Ceylon, while the remaining 34 genera are common to the Indo-Gangetic plain, Indian Peninsula and Burma.

The Malnad is the western part of the State ; it is composed of hilly tracts with peaks ranging from 4,000 to 6,000 feet above sea level. Blanford included this area in his Malabar Tract—"Western Ghats and the western coastlands of the Peninsula from the Tapti River to Cape Comorin." The Nilgiris, the Wynaad and Coorg are definitely included in the Malabar tract. According to Blanford's lists, the following additional genera are found in the Malabar tract of the Mysore State :

Silurus
Homaloptera (in part=*Bhavania*)
Scaphiodon (in part=*Osteochilus*)
Sicydium (in part=*Sicyopterus*).

[1] In a foot note, Blanford observed that "This boundary should perhaps be placed further south. Originally these tracts were arranged to mark the distribution of the Cyclophoridae. After going through all the evidence, I am inclined to think that a more important line might be drawn about 12°N. lat.".

These genera have a restricted and discontinuous distribution in India. According to Blanford's tables, *Silurus* is found in the Malabar tract, the Eastern Himalayan tract, the Assam tract, and the Tenasserim tract. Formerly two or three species of *Silurus* were recognised from within the limits of India, but, as indicated above, Bhimachar and Subba Rau have shown that it is the same species that is found from Cochin-China to the Eastern Himalayas and also in the Western Ghats. Similarly, the Homalopteridae, of which *Bhavania* is a highly specialised member, are found throughout south-eastern Asia up to the Eastern Himalayas and the hills of Assam, and also in the Western Ghats. These two genera, recorded by Bhimachar and Subba Rau from the Kadur District, represent the so-called Malayan element in the fauna of Mysore. I[1] have recently shown that Day's three species of *Scaphiodon* from Peninsular India are referable to *Osteochilus*, a genus widely distributed in south-eastern Asia. In the same place it has been shown that *Cyprinus nukta* Sykes belongs to the Malayan genus *Schismatorhynchus* which was hitherto known only from Sumatra and Borneo. *Sicydium* is recorded from the Malabar and the Northern Ceylon tracts and from the Malay Peninsula. It is a Gobioid genus, which seems to have invaded fresh waters from the sea and for this reason its distribution is not of much significance. Law and the present writer[2] have recently discussed the significance of the Malayan element in the fauna of Peninsular India and the route of dispersal of the above-noted forms from their original home in south-eastern Asia to the Western Ghats.

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[1] Hora, S. L. *Rec. Ind. Mus.* XLIII, pp. 1-14 (1941).
[2] Hora, S. L. and Law, N. C. *Rec. Ind. Mus.* XLIII, pp. 233-256 (1941).

THE FISH OF SEISTAN.

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(Plates XV—XVII.)

INTRODUCTION.

The fish of Seistan have a particular interest on account of their geographical isolation and of the peculiar structural modifications that some of them possess. An account of the geography of the country, in so far as it affects the aquatic fauna, will be found in the Introduction to this volume. It may be well, however, to reiterate here the fact that Seistan is a comparatively deep depression (less than 2,000 feet above sea-level), and lies surrounded by desert and mountains much higher than itself. Its only connection by water with the outside world (apart from a few short and fitful streams that flow into it from the Afghan hills directly to the north) is the Helmand, which runs through the Afghan desert from the mountains in the north-eastern part of that country. Seistan is, in an almost literal sense, the child of the Helmand, which alone makes it a living country. Moreover, no ancient connection with any sea or any other large river can be premised.

The following nine species of fish are known to us from Seistan or its immediate section of the Helmand system :—

Fam. CYPRINIDAE.

Subfam. CYPRININAE.
Discognathus adiscus.
*Discognathus phryne.**
Scaphiodon macmahoni.

Subfam. SCHIZOTHORACINAE.
Schizothorax zarudnyi.
Schizopygopsis stoliczkae.†
Schizocypris brucei.‡

Fam. COBITIDAE.

Nemachilus stoliczkae.†
Adiposia macmahoni.
Adiposia rhadinaea.

The species whose name is marked with a * is also found in the hills of northern Baluchistan; those with a † are widely distributed in the headwaters of the rivers that run northwards from the Himalayas and the Hindu Kush, while that with a ‡ is only known, apart from Seistan, from the mountains of Waziristan on the North-West Frontier of India. The rest, so far as we know, are endemic in Seistan.

These endemic species belong to two categories, those allied to fish that live at high altitudes in Central Asia, and those allied to representatives of the fish-fauna of Baluchistan. To the former category belong *Schizothorax zarudnyi* and the two species of *Adiposia*, to the latter (with which may be classed *Discognathus phryne*) *D. adiscus* and *Scaphiodon macmahoni*. The fish-fauna of Seistan may, indeed, be separated as a whole into two geographical divisions. The Cyprininae, which do not occur in the highlands of Central Asia, represent an element derived from the country lying south and south-east of the Helmand basin; while the Schizothoracinae and the Cobitidae have been brought by the Helmand from the Hindu Kush and are probably descended from the fish-fauna of the ancient and once extensive Oxus system. There is very little affinity with the scanty fish-fauna of the Persian plateau, a noteworthy difference being the complete absence of the Cyprinodontidae, several species of which, as Jenkins[1] has shown, are common in the Shiraz district.

We have as yet little information about the fish of north-western Baluchistan and the adjacent parts of Afghanistan, which are not remote from the sources of the Helmand system, but probably these fish will be found to have Central Asiatic affinities and to be closely related to those of Seistan. The fish of southern Baluchistan seem to be quite distinct. They have recently been discussed by Zugmayer,[2] whose collection was mainly from Las Bela, Kelat and the Mekran. The fish-fauna of south-eastern Baluchistan was described many years ago by Day,[3] with a few records from the Quetta district, in his account of that of south-eastern Afghanistan; McClelland[4] as long ago as 1838 published descriptions of a good many species from the Kabul district, and Gunther[5] discussed a comparatively small collection, mainly from the Murghab river in western Afghanistan, in 1889. Not a single species recorded from any of these districts (except *Discognathus phryne* from Quetta) has been found in Seistan. We must look still further north for the main origin of its fish-fauna, and to a country lying at much greater altitudes above sea-level. This fauna, indeed, is a remarkable instance of the acclimatization of a mountain fauna in a low-lying swampy depression.

The acclimatization has probably taken place in comparatively recent times, and the question naturally arises, how far has it affected the structure of the fish? Before attempting to answer this question, however, it is necessary to say a little more about the *provenance* of the collections on which we have worked, and

[1] Jenkins, *Rec. Ind. Mus.*, V, p. 123 (1910).

[2] Zugmayer, "Die Fische von Baluchistan," *Abh. k. Bayerischen Ak. Wiss.* (*Math.-phys. Klasse*), XXVI, pt. 6 (1913).

[3] Day, "On the Fishes of Afghanistan." *Proc. Zool. Soc. London*, p. 224 (1880).

[4] McClelland, *Journ. As. Soc. Bengal*, VII (2), p. 944 (1838).

[5] Gunther in Aitchison's "The Zoology of Afghan Delimitation Commission," *Trans. Linn. Soc. London*, V (2), p. 106 (1889).

the precise circumstances in which the different species were obtained.

Our specimens represent two collections, one made by Sir Henry McMahon and the other officers of the Seistan Arbitration Commission of 1902-1904, the other by officers of the Zoological Survey of India in the winter of 1918.

The specimens from the first of these collections are labelled, without further particulars, as being from Seistan; but in an editorial note prefixed to the description of two new species by Mr. Tate Regan,[1] it is stated that they came from "affluents of the Helmand." Now, the Helmand has no affluents in Seistan or anywhere near Seistan; none, indeed, in any district where other zoological collections were made by the Commission. We believe, therefore, that "affluents" is a *lapsus calami* for "effluents," and that the fish are from the lower parts of the Helmand system—if not actually from Seistan in all cases, at any rate from the adjacent parts of the Afghan desert. This is borne out by information kindly given us by Sir Henry McMahon, who writes, "The fish collected by us were to the best of my belief all from the Rud-i-Seistan near our permanent camp near Kuhak close to the take off of the Rud-i-Seistan from the Helmand....... Everything we got was of course from the 'deltaic mouths' of the Helmand and the area of the delta."

There is no doubt as to the more recent collection. It was made by Dr. N. Annandale and Dr. S. W. Kemp in small water-channels in the plains of Seistan, in pools in the desert and in half-dried beds of effluents of the Helmand in the same district, and in the Hamun-i-Helmand, the lake-basin into which that river ultimately drains.

Even in winter the smallest water-channels, provided they were of a permanent nature, were found to swarm with *Discognathus adiscus* and among large numbers of this species a single specimen of *D. phryne* was found at Nasratabad. *D. adiscus* was obtained in much smaller numbers in the reed-beds of the Hamun at the same season, but for some reason all the individuals seen were dead or dying, though healthy fish of the same species were captured in a small reedy water-course connected with the lake. The species occurred in enormous numbers, with young *Schizothorax zarudnyi* and a few young *Schizocypris brucei*, in bare pools of very foul water in the bed of the Randa stream near the ruined city of Jellalabad (not to be confused with the modern town of the same name in Afghanistan). Here again, for more obvious reasons, the fish were dead or dying, or rather the Cyprinidae were doing so, for the loach *Adiposia macmahoni*, which was buried in the mud at the bottom, was quite healthy. In the Hamun-i-Helmand itself the only fish that was apparently at all common in winter was *Schizothorax zarudnyi*, of which only adult specimens were obtained from the lake. This species was originally

[1] Regan, *Journ. As. Soc. Bengal*, II, p. 8 (1906).

described from the *Naizar* or "reed-country" that surrounds the Hamun.

Of the seven species[1] represented in the collection of the Arbitration Commission only three (*Discognathus phryne*, *Adiposia macmahoni* and *Schizothorax zarudnyi*) are common to it and the one of five species recently obtained. This is probably to be explained by the fact that the former collection was mainly if not exclusively of fluviatile origin, while the other was paludine or lacustrine, or at any rate not from rapid-flowing water.

We may now consider the question of structural modification in the Seistan fish, distinguishing carefully between those peculiarities they brought with them from their mountain home and those that may have been evolved in the basin of the Helmand.

A striking feature of the fish-fauna of Seistan is the degenerate nature of the scales. The degeneracy is not of the same kind, however, in all the species. In the *Schizothorax*, the *Schizopygopsis* and the *Schizocypris*—as, indeed, in all Schizothoracinae—the scales are small, partly buried in the skin and (if not completely degenerate) non-imbricate or almost so in the living fish, except in the anal and scapular regions. In *Discognathus phryne* they have almost completely disappeared on the ventral and dorsal regions, remaining normal in shape and size, but somewhat deciduous, on the sides; in *Scaphiodon macmahoni*, while normal on the sides and back, they are absent or degenerate on the ventral surface. In the three Cobitidae scales are altogether absent or merely vestigial. Only in *Discognathus adiscus* does the lepidosis appear quite normal, and in this species the scales are so deciduous that carelessly preserved specimens are almost naked.

The Schizothoracinae are the dominant fish of the streams and marshes of the high plateau of Central Asia, the waters of which they share with the Cobitidae, most of which are practically scaleless. Small size or absence of scales is, therefore, a conspicuous feature of the fish-fauna of that region, and the plates of Herzenstein's[2] great monograph offer in this respect a striking contrast to those illustrating the Cyprinidae in Day's *Fishes of India*. If, therefore, it had been only the Schizothoracinae and the Cobitidae which had manifested in Seistan signs of degeneracy in the scales, all that could have been said would have been that they were descended from species that possessed this feature, and provided no evidence that life in a low-lying country was affecting ancestral characters in this respect. The case would have been to some extent parallel to that of Salmonidae confined in land-locked waters, for the small size of the scales in both the Schizothoracinae and the Salmonidae is probably due to the importance of a supple

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[1] *Discognathus variabilis*, *Scaphiodon macmahoni*, *Schizothorax zarudnyi*, *Schizopygopsis stoliczkae*, *Nemachilus stoliczkae*, *Adiposia rhadinaea*, *Adiposia macmahoni*.

[2] Herzenstein, *Fische*, in *Wiss. Res. Przewalski Central-As. Reis. Zool.*, III, (2), (18

integument in rapid-running water. Similarly with the Cobitidae, which have probably lost their scales in acquiring the burrowing habit. But the fact that the Cyprininae also of Seistan are, as it were, casting off their scaly garment and by a different process from either the Cobitidae or the Schizothoracinae, suggests that the phenomenon has some other, strictly local significance, and that there is something in the environment of these fish that renders scales an encumbrance rather than a protection. But what this something is, we do not know.[1]

Another general peculiarity of the fish of Seistan, possibly correlated with the degeneracy of the scales, is the brittleness of their fin-rays. This feature is so well-marked that difficulty was experienced in preserving specimens with the caudal and dorsal fins intact. Possibly both phenomena may be due, directly or indirectly, to the peculiar composition of the water in which these fish live; but this is a mere suggestion.

The species all seem to be mainly bottom-feeders, with at least partly ventral mouths and more or less flattened ventral surfaces. They do not, however, possess any highly specialized tactile organs, and their eyes, though rather small, are not degenerate. The fins are small, but at any rate in the Schizothoracinae and Cobitidae, much larger proportionately in the young than in the adult.

This is all we can say about the structural peculiarities of the fish-fauna of Seistan as a whole, but in two of the three species of Cobitidae a remarkable peculiarity occurs, namely, the persistence of the posterior part of the primitive dorsal fold in the form of a soft or adipose fin. This peculiarity has not been commented on hitherto in any Cyprinoid fish. It is not, however, found only in species from Seistan, for it is figured, apparently without comment in the Russian description, by Kessler in his *Nemachilus longicauda* from Turkestan. Moreover, as we will demonstrate later, the soft fin in these fish differs little in fundamental structure from the fold present in a young post-larval stage in the allied genus *Nemachilus*. Its persistence and slight modification in the species to which we give the generic name *Adiposia* is probably correlated with the necessity of burrowing in the mud in periods of drought. We will discuss the homology and function of the structure in detail when describing the genus.

All we can say, therefore, on the subject of structural modification in the fish of Seistan is that they are in several instances specialized forms, but that apart from a certain degeneracy of the scales, their specialization is not the result of evolution in their present home, but of long anterior specialization in the mountains of Central Asia. Their migration to the swampy

[1] A suggestion has been made to us that the disappearance of the scales may be correlated with increased necessity for respiration by means of the skin, but this could hardly be affected by deciduous scales, which are only lost when the fish suffers rough treatment.

basin of Seistan has been in all probability too recent for any very marked change to have taken place in their structure, and, as is so often the case when a fauna survives in abnormal conditions, structural peculiarities are on the whole less marked than a physiological vigour and a power of reproduction sufficient to overcome adverse factors in the environment. It is too often forgotten that physiological evolution may take place, and frequently does take place, without visible bodily change.

DESCRIPTION OF THE FAUNA.

All the fish in the fauna of Seistan belong to the suborder Cyprinoidea and to the families Cyprinidae and Cobitidae. Those representing the former family belong to the two subfamilies Cyprininae and Schizothoracinae. Three species fall in the Cobitidae, and three in each of the subfamilies of Cyprinidae.

KEY TO THE FISHES OF SEISTAN.

A. Scales of large or moderate size present on some part of the body ; posterior pharyngeal bones stout, bearing coarse teeth arranged as a rule in more than one row ; air-bladder large, free	Cyprinidae.
1. Lateral scales of large or moderate size, much less than 100 in lateral line ; no greatly enlarged scales in the region of the vent	Cyprininae.
a. Lower jaw sharp, with an internal horny sheath ; no adhesive disk behind the mouth...	*Scaphiodon.*
Scales 37-39 $\frac{7}{8}$, 2 barbels ; diameter of eye 4 to $4\frac{1}{2}$ times in length of head, depth of body $3\frac{3}{5}$ to $3\frac{4}{5}$ in total length	*S. macmahoni.*
b. Lower jaw blunt, without a horny sheath ; an adhesive disk behind the mouth ...	*Discognathus.*
i. Ventral surface covered with scales ; 4 barbels ; adhesive disk without posterior free border	*D. adiscus.*
ii. Chest naked ; 2 barbels ; posterior border of adhesive disk free ...	*D. phryne.*
2. Lateral scales, if present, small, more than 100 in the lateral line ; a sheath of greatly enlarged scales in the anal region	Schizothoracinae.
a. No lateral scales ; a scapular patch of enlarged scales present ; no barbels ; lower jaw sharp	*Schizopygopsis.*
Mouth extending backwards nearly as far as or slightly beyond the anterior border of the eye ; pectoral fin much shorter than head ...	*S. stoliczkae.*
b. Lateral scales present.	
i. Mouth terminal or subterminal, lower jaw blunt ; ventral scales present ; 4 barbels	*Schizothorax.*
Scales at base of fins slightly enlarged ; anal sheath rather poorly developed ; lips normal	*S. zarudnyi.*
ii. Mouth ventral ; lower jaw sharp, ventral scales absent ; barbels vestigial or absent	*Schizocypris.*
Origin of dorsal equidistant from eye and base of caudal, above posterior part of pelvic	*S. brucei.*

B. Scales vestigial or absent; posterior pharyngeal bones slender, bearing a single row of slender teeth; air-bladder small, enclosed in bone; at least 6 barbels present ... ... Cobitidae.

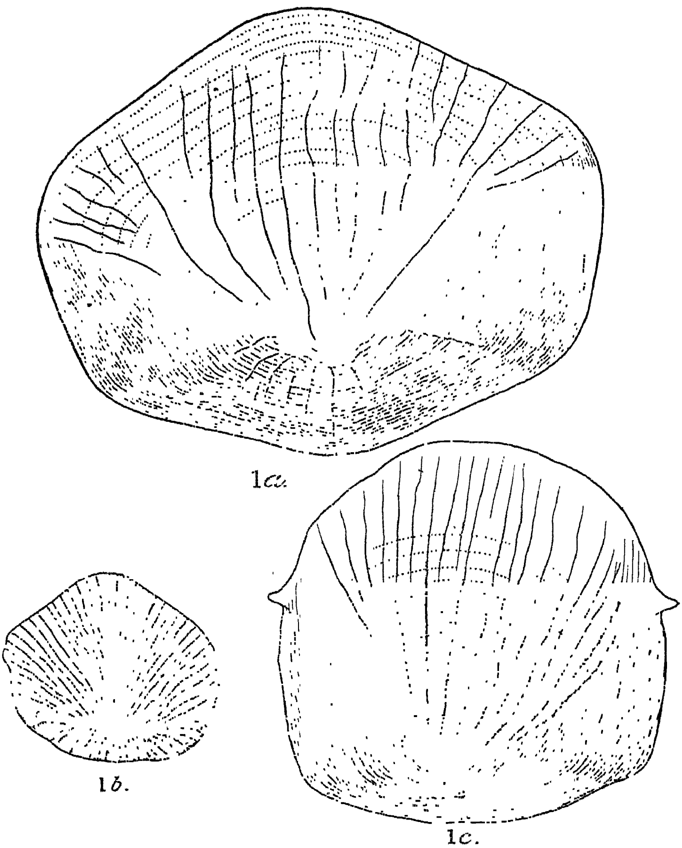
1. No soft dorsal fin ... ... *Nemachilus.*

   Caudal peduncle at least 3 times as long as deep, length of head 4–4¾ times in total length (without caudal) ... ... *N. stoliczkae.*

2. A ridge-like soft dorsal fin present ... ... *Adiposia.*

   a. Dorsal and ventral profiles straight, parallel... *A. rhadinaea.*

   b. Dorsal profile irregular owing to the depression of the head and the convexity of the anterior part of the back. ... . *A. macmahoni.*



TEXT-FIG. 1.—Scales of Cyprininae.

a. Dorso-lateral scale of *Scaphiodon macmahoni*, × 17½.
b. Dorso-lateral scale of *Discognathus phryne*, × 17½.
c. Dorso-lateral scale of *Discognathus adiscus*, × 17½.

Family CYPRINIDAE.

Subfamily *CYPRININAE.*

The Cyprininae are a dominant group in the fish-fauna of India and are well represented even in that of Baluchistan and

Sind. They form a large proportion of that of Persia and are abundant in western Asia. In Seistan, however, only three species and two genera are known, and these are the only species (except possibly *Schizocypris brucei*) that are not of direct Central Asiatic ancestry.

The two genera are *Discognathus*, Heckel (which we distinguish from *Garra*, Ham. Buch.) and *Scaphiodon*, Heckel. Both these genera probably originated in south-western Asia, but whereas *Scaphiodon* has proliferated specifically in Baluchistan and has extended its range from southern Arabia southwards and eastwards through Mesopotamia and southern Persia, along the Mekran coast and through Sind to the Malabar Zone of Peninsular India, *Discognathus*, of which only a few species are known, occupies a region extending from the North-West Frontier of India to Syria. Since or shortly before reaching India, however, it gave rise to a more highly specialized offshoot (*Garra*) which has separated into many species in the Peninsula and ranges, possibly from Syria[1] to Borneo and southern China. *Scaphiodon*, *Garra* and probably *Discognathus* occur together in Oman.

Genus Scaphiodon, Heckel.

1878. *Scaphiodon*, Day, *Fishes of India*, II, p. 550.
1913. *Scaphiodon*, Zugmayer, *Abh. Wiss. K. Bay. Ak.* (*Math.-phys. Klasse*), XXVI, p. 28.

The geographical distribution of this genus is peculiar. It seems to centre in Baluchistan, in which no less than six distinct species occur. Thence it extends westwards to Persia and southern Arabia and southwards through Sind down the Malabar Zone of Peninsular India and inland as far as the base of the Nilgiris.

Zugmayer (*op. cit.*) discusses the species known from Baluchistan and Seistan.

Scaphiodon macmahoni, Regan.

1906. *Scaphiodon macmahoni*, Regan, *Journ. As. Soc. Bengal*, II, p. 8.

To facilitate reference we quote Mr. Tate Regan's description of the species:—

"Depth of body $3\frac{3}{5}$ to $3\frac{4}{5}$ in the length, length of head $4\frac{1}{5}$ to $4\frac{2}{5}$. Snout obtuse, shorter than the post-orbital part of head. Diameter of eye 4 to $4\frac{1}{2}$ in the length of head, interorbital width $2\frac{3}{5}$, $2\frac{2}{3}$. Mouth inferior; lower jaw with nearly straight transverse anterior edge; barbel originating directly below the nostril, shorter than the eye. Scales $37\text{-}39\frac{7}{8}$, 4 between lateral line

[1] The systematic position of the Syrian *Discognathus rufus*, Heckel, previously regarded by one of us as a race of *D. lamta*, Ham. Buch. is doubtful. No specimens are at present available to us, but the figure published in the *Journal of the Asiatic Society of Bengal* (N.S.) IX, p. 37, fig. 2, suggests that the species is a true *Discognathus* (*s.s.*).

and root of the ventral fin, 16-18 round the caudal peduncle; the two rows above the lateral line the largest; scales of the lower part of the abdomen small or rudimentary. Dorsal III, 10, its origin equidistant from tip of snout and base of caudal; third simple ray moderately strong, serrated in its basal half, $\frac{2}{3}$ to $\frac{3}{4}$ the length of the head and $1\frac{1}{4}$ as long as the last branched ray, free edge of the fin straight. Anal III, 6-7, the second branched ray a little longer than the first or the third and twice as long as the last, as long as or little longer than the longest dorsal ray. Pectoral, a little shorter than the head, extending $\frac{2}{3}$ or $\frac{5}{7}$ of the distance from its base to the base of ventral. Ventrals originating below the first branched ray of dorsal, extending nearly to the origin of anal. Caudal forked. Caudal peduncle $1\frac{1}{2}$ to $1\frac{3}{4}$ as long as deep, its last depth not more than $\frac{1}{2}$ the length of head. Greyish above, silvery below, fins pale or somewhat dusky.

Two specimens 70 and 110 mm. in total length. The larger with tubercles on the snout and on the rays of the anal fin.

Cyprinion kirmanensis, Nikolski, 1899, appears to be allied to this species, but differs at least in the larger eye, the thick and strongly serrated last simple dorsal ray, the form of the dorsal fin and the coloration."

The lateral scales agree fairly well with Cockerell's [1] description of those of other species of the genus but differ in having ill-developed radii on the basal part and in lacking tubercles between the radii. The base resembles that of his figure of the scale of *S. muscatensis*. Those on the ventral surface are entirely buried in the skin. They all appear circular on the surface, but the larger ones are sub-triangular, the distal end being produced and bluntly pointed. The smallest ventral scales are transversely oval and have the nucleus nearly central. Their basal radii are well developed. A large scale from the row above the lateral line has the following measurements:—length 3·9 mm., breadth 4·2 mm., distance of nucleus from base 0·8 mm.; in a sub-triangular ventral scale they are, length 1·7 mm., breadth 1·8 mm., distance of nucleus from base 0·5 mm.; in a small transversely oval ventral scale, length 1·1 mm., breadth 1·3 mm., distance of nucleus from base 0·5 mm.

Only two specimens are known, both collected by the Seistan Arbitration Commission in the delta of the Helmand. We have examined the larger of the two, which is preserved in the Indian Museum. The tubercles on its snout and fins referred to by Regan

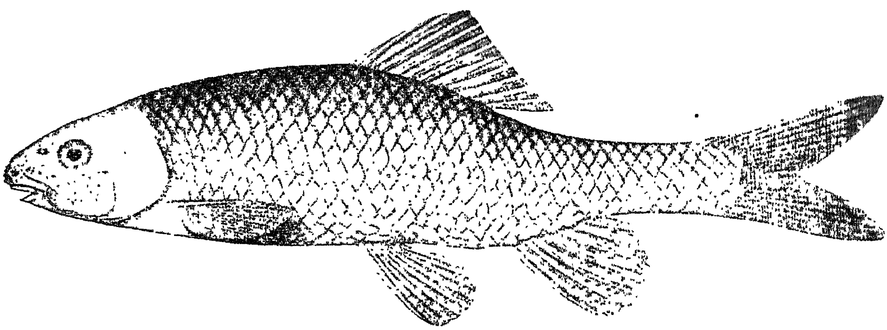
[1] Cockerell, *Bull. Bur. Fisheries* (Washington), XXXII, p. 138, pl. xxxiii, fig. 10 (1912).

are of parasitic origin, as is shown in the following note, for which we have to thank Dr. Baini Prashad:—

"The tubercles noted by Regan in the description of the large specimen of *S. macmahoni* are due to the encysted glochidia of some Unionid. The arrangement of these parasites in this specimen is rather striking. There are three to five slightly irregular rows on the snout and the region of the head below the eyes. On the anal fin there are six parallel rows following the lines of the fin-rays on either face.

The number of glochidia in each row varies from about three to ten. In addition to those in the two situations noted by Regan in his account, there are a few glochidia encysted on some of the scales of the ventro-lateral regions of the body between the ventral and the anal fins.

Owing to the glochidia being in an advanced stage of encystment and the poor preservation of the specimen, it is not possible



TEXT-FIG. 2.—One of the type-specimens of *Scaphiodon macmahoni* with encysted glochidia on head and fins.

to ascertain all the larval characters. It is, however, clearly seen that the hinge-line is not straight but curved, and that the surface of the shell-valves is minutely sculptured.

Owing to our limited knowledge of the anatomy of the Seistan Unionidae it is not possible to assign the glochidia to any definite species, but they may possibly belong to *Lamellidens marginalis* subsp. *rhadinaeus*, Annandale and Prashad,[1] a form widely distributed in the basin of the Helmand river and recently described."

Scaphiodon macmahoni, Regan (type).

Measurements (in millimetres), number of fin-rays, scales and proportions:—

1. Total length (including caudal)	114·6	mm.
2. Length of caudal	22·2	,,
3. Greatest depth of body	25·4	,,
4. Length of head	21·3	,,

[1] *Rec. Ind. Mus.*, XVIII, pp. 59-62, pl. viii, figs. 7-11 (1919).

5.	Width of head	14·7
6.	Length of snout	8·0
7.	Diameter of eye	4·5
8.	Interorbital width	8·2
	Longest ray of dorsal	16·7
10.	,, ,, ,, anal	17·9
11.	Length of pectoral ...	17·4
12.	No. of branched rays in dorsal ...	10
13.	,, ,, ,, ,, anal ...	6
14.	No. of scales in L.L.	38
15.	,, in T. Series above L.L.	7½
16.	,, below L.L. ...	12½
17.	between L.L. and Ventral	4½
18.		*5·16*
19.		*4·51*
20.		*5·38*
21.		*4·73*
22.	1-Caudal	*4·16*
23.	$\frac{\text{1-Caudal}}{3}$	*3·63*
24	1-Caudal	*4·33*

Discognathus, Heckel.

1843. *Discognathus*, Heckel in Russeger, *Reisen*, I, 2, p. 1027.
1863. *Discognathus* (s.s.), Bleeker, *Atl. Ichth.*, III, p. 24.
1919. *Discognathus*, group of *D. variabilis*, Annandale, *Rec. Ind. Mus.*, XVIII, p. 67.

The genus as restricted may be defined as follows:—

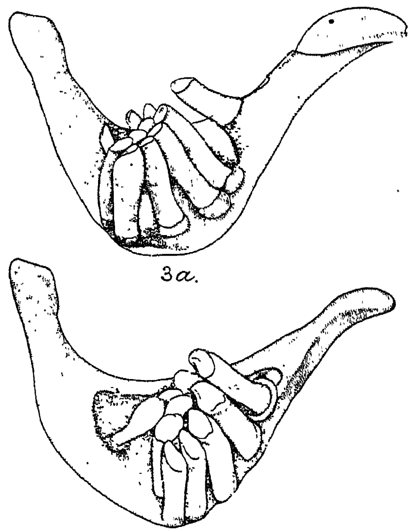
Cyprininae with a ventral mouth situated only a short distance behind the tip of the snout, with exposed cartilaginous jaws without horny covering, a fringed membranous, tuberculate upper lip, a vestigial lower lip; situated behind the mouth a more or less well-defined adhesive disk less than half as wide as the head and consisting of a semi-cartilaginous pad with or without an anterior but always without a posterior specialized border, at least partially free round the margin but often adherent at the sides or posteriorly. The snout not modified in either sex. Seven or 8 branched rays in the dorsal fin and 5 in the anal. Form compressed, but ventral surface slightly flattened. Branchial opening moderate; opercular and praeopercular borders meeting those of the opposite side at an acute angle on the ventral surface some distance behind the adhesive disk; branchial isthmus narrow. Scales at least nearly as broad as long, somewhat deciduous in the species examined, with well-defined radii at any rate on the distal part and concentric transverse striae at the base. Pharyngeal bones delicate, bearing 11 elongate fixed teeth and at least one free, minute tooth; dental formula (omitting free teeth) 5·3·3 3·3·5 or 5·4·2 2·4·5: teeth closely crowded together.

Type-species: *D. variabilis*, Heckel (selected by Bleeker).

This genus is distinguished from *Garra* (s.s.) by the more anterior position of the mouth, the less complex structure of the adhesive disk, less flattened ventral surface, and narrow branchial

isthmus. From *Cirrhina* and *Crossochilus* it is separated by the presence of an adhesive disk on the ventral surface of the head. The jaws are also less sharp and not so bony. They have no trace of horny covering. Further, except in *Cirrhina afghana* from the Nushki desert, the characters of which are very divergent, the scales of the Indian species of *Cirrhina* are always distinctly longer than broad. The teeth also are stouter than those of *Discognathus*.

The relationship of *Discognathus* to *Garra* seems fairly clear. There can be no doubt that the former is the more primitive of the two, departing less from the normal Cyprinid type. This is borne out not only by the structure of the adult *Discognathus*

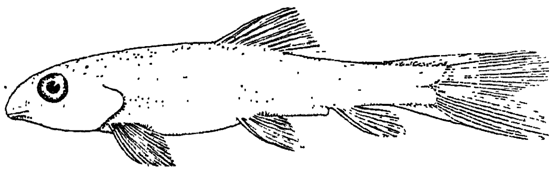


TEXT-FIG. 3.—Pharyngeal teeth of *Discognathus*.
a. D. adiscus.
b. D. phryne.

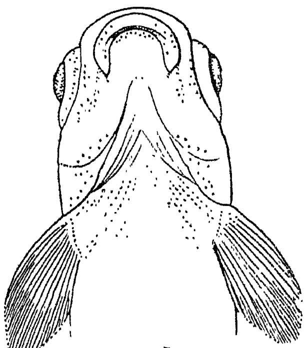
but also by the fact that the young *Garra* passes through a stage in which the structure of the head agrees with that of *Discognathus*. We figure a young specimen of *G. nasutus* 7·4 mm. long, illustrating this point, with one of about the same size of *Psilorhynchus* for comparision. It will be seen that its adhesive mental disk and also its branchial isthmus closely resemble those of *D. adiscus* (*Rec. Ind. Mus.*, XVIII, pl. xi, fig. 1). We refrain from discussing this point further because Prof. D. R. Bhattacharyya of Allahabad is at present engaged in a detailed study of the anatomy of the mouth-parts, etc., of these fish.

The genetic relationship in the opposite direction between *Discognathus* on the one hand, and *Crossochilus* and *Cirrhina* on the other, though undoubtedly close, is not yet capable of full

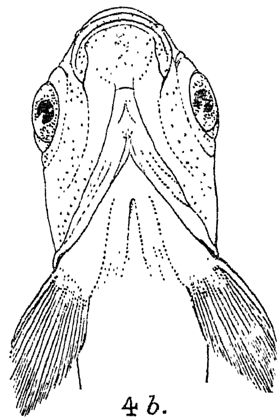
discussion, which would involve an examination not only of all the Indian species assigned to *Cirrhina* but also of the Malayan ones assigned to *Crossochilus*. We have made a somewhat cursory survey of the former but find so much diversity of structure and



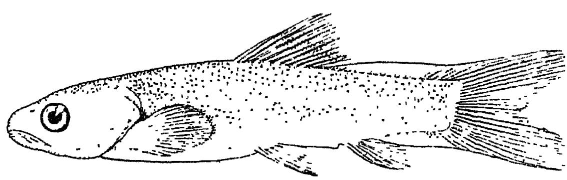
4 *c*.



4 *d*



4 *b*.



4 *a*.

TEXT-FIG. 4.—Young of *Garra nasuta* and *Psilorhynchus tentaculatus*.

a. Lateral view of young *D. nasuta* showing dorsal fold (magnified).
b. Lower view of head of same fish (further magnified) showing resemblance of ventral disk to that of *Discognathus adiscus*.
c. Young of *Psilorhynchus tentaculatus* at a slightly later stage of development (magnified).
d. Dorsal view of head of same fish (further magnified) showing complete absence of disk.

so little correlation between the different peculiarities noted in certain species by former authors, that we think it best to put the subject aside for further consideration when more material from the Malay Peninsula and Archipelago is available.

Another point on which a few words may be desirable is that of the use of the names *Discognathus* and *Garra*. The former was first applied by Heckel [1] to a group of fishes including species of both genera. The original work is not available in India, and we have to thank Mr. Tate Regan for the information that Heckel did not designate a type-species. Bleeker,[2] however, in 1863, while accepting *Garra* as a generic name, recognized *Discognathus* as a subgenus, for which he selected *D. variabilis*, a form closely allied to *D. phryne*, as type-species. The fact that he based the subgeneric division on the number of barbels, an unimportant character, does not invalidate his nomenclature, and if the group of which *D. variabilis* is a member is to be regarded as a distinct genus there can be no dispute as to its proper name.

The status of the name *Garra* is a little more doubtful. It was first proposed by Buchanan [3] as that of a division of *Cyprinus*, for a heterogeneous collection of convergent species including forms now referred to *Cirrhina*, *Psilorhynchus* and *Balitora*. No type-species was selected, but *Cyprinus lamta* was described first, and the name of the division was that given locally to this fish. As has been pointed out in a former note in this volume (p. 77), it is doubtful what *Cyprinus lamta*, which may have been a composite species, really was; but there can be no doubt that it was a member or set of members of the genus we now call *Garra*.

Various other names were applied to species of the same genus by the earlier writers on Indian ichthyology, such as *Chondrostoma*, *Goniorhynchus* and *Platycara*. The only one of these that need be considered is the last, as the others were originally given to fish unrelated to the Indian species. *Platycara* was coined by McClelland in 1838 to take the place of *Balitora*, Gray, which he regarded as barbarous and etymologically incorrect. Gray's *Balitora*, as is clear from the figure in the "Illustrations" (fig. 192, pl. 68) was a Homalopterid, but the only species definitely assigned to *Platycara* by McClelland in his earlier work [4] was *nasutus*, which is equally certainly congeneric with Buchanan's *Cyprinus* (*Garra*) *lamta*. In the same paper McClelland described the genus *Psilorhynchus*, for another species included by Buchanan in his group *Garra*, and the name *Platycara* is printed above that of *Psilorhynchus*. No one has disputed McClelland's right to separate this genus from *Garra*. In a slightly later, more comprehensive and better-known work,[5] however, McClelland definitely placed Gray's *Balitora maculata* in his genus *Platycara*, and as the earlier paper was clearly not meant to be comprehensive, it may be assumed that he always intended that this species should be what is now called the type-species of the genus.

[1] Heckel in Russegger, *Reisen*, I, 2, p. 1027 (1843).
[2] Bleeker, *Atl. Ichth.*, III, p. 24 (1863).
[3] Buchanan, "*An Account of the Fishes of the Ganges*" (1822).
[4] McClelland, *Journ. As. Soc. Bengal*, VII, p. 944 (1838).
[5] McClelland, *Asiatic Researches*, XIX, p. 246 (1839).

The name *Garra* was used in a double sense by Bleeker,[1] as that of a genus, in which he included species of both the genera recognized by us, and also (*sensu stricto*) as that of a subgenus, from which he excluded the species accepted by us as the type-species of *Discognathus*. Buchanan was not acquainted with any form belonging to this latter group, which is not found in the territory explored by him.

Taking all these facts into consideration, we accept Jordan and Evermann's [2] finding that *Garra*, Ham. Buch. is the correct generic name of the species assigned by Day to *Discognathus*, but much of the synonymy in the *Fishes of India* under the latter name is incorrect.

Discognathus adiscus, Annandale.

1919. *Discognathus adiscus*, Annandale, *Rec. Ind. Mus.*, XVIII, p. 68, pl. x, fig. 2, pl. xi, fig. 1.

The formula of the pharyngeal dentition is capable of two interpretations. Omitting the minute free teeth (found not only in this genus but also in *Garra* and *Cirrhina*) it may be read either 5·4·2 2·4·5 or 5·3·3 3·3·5. The scales[3] are subcircular, but slightly longer than broad, sinuate at the base and rounded distally. Some have a pair of lateral processes as shown in fig. 1. They have nine or ten radii, which proceed obliquely forwards. About half of these radii arise near the nucleus, which is situated at about a sixth of the distance between the base and the distal margin ; the others are much shorter and arise nearer the distal margin ; long and short radii alternate, but not always. There are about 10 to 12 transverse striae near the base in fully formed scales. Dentritic blotches and minute round dots of pigment are scattered on the distal part. The measurements of a large lateral scale are as follows :—length 3 mm., breadth 2·7 mm., distance of nucleus 0·45 mm.

We give measurements, etc. of a series of specimens from Seistan.

In many respects this is the most primitive species of the genus known and the most closely related to *Cirrhina*. It is interesting to observe that the young of *Garra nasuta*[4], one of the most highly specialized member of its genus, passes through a stage at which the mental disk is very similar to that of *D. adiscus*.

D. adiscus lives in still or sluggish water and feeds on algae on a muddy bottom. It is markedly gregarious and may sometimes be seen on the surface of water-channels in the evening in shoals. In the plain of Seistan *D. adiscus* and the young of *Schizothorax zarudnyi* are almost equally abundant in pools left in

[1] Bleeker, *Atl. Ichth.*, III, p. 24 (1863).
[2] Jordan and Evermann, *The Genera of Fishes*, p. 115 (1917).
[3] This statement is not in verbal agreement with that of Cockerell, *Bull. Bur. Fish.* (Washington), XXXII : 1912) ; but the question is one of degree.
[4] See Annandale, *Rec. Ind. Mus.* XVI, p. 132, pl. ii, fig. 2.

dry stream-beds in December. They perish annually in enormous numbers at this season as the water grows salt or foul owing to evaporation or to the excreta of large flocks of sheep and goats belonging to the nomad tribes who camp near the stream-beds. The *Discognathus* is found, alone or with *D. phryne,* also in permanent irrigation channels and is very abundant in those that supply the garden of the British Consulate at Nasratabad or Shahr-i-Seistan. A few moribund individuals were caught at the same season in the reed-beds of the Hamun-i-Helmand, but the reason why they were dying was not apparent, for the water was neither salt nor foul. Numerous healthy individuals were captured in a reedy canal leading out of the Hamun a few days later.

Discognathus adiscus, Annandale.

Measurements (in millimetres). Number of Fin-rays, Scales and Proportions.

1	Total length (including caudal)	50·5	58·9	41·0	70·4	41·5	56·3	57·3	54·8	63·7	60·0	52·3	46·0
2	Length of caudal ..	11·0	13·0	9·0	14·6	8·2	13·0	13·1	11·4	14 0	13·0	11·8	10·0
3	Greatest depth of body.	9·0	10·7	8·0	13·6	8·1	11·0	11·0	9·5	11·0	10·2	10·0	7·0
4	Length of head ..	9·5	11·5	7·5	12·9	8·0	10·6	10·8	10·3	11·5	10·6	10·4	9·0
5	Width of head ..	7·8	8·2	5·6	9·0	6·1	7·8	7·8	7·0	7·8	8·6	7·2	6·2
6	Length of snout ..	3·3	4·6	3·0	5·0	3·2	3·9	4·5	3·5	4·0	4·0	3·8	3·0
7	Diameter of eye ..	2·5	2·9	2·2	3·3	2·4	3·0	3·1	3·0	3·3	3·0	2·1	2·6
8	Interorbital width ..	4·3	5·0	4·0	6·8	4·0	5.0	5·0	4·9	5·0	5·2	5·0	4·2
9	Longest ray of dorsal.	9·2	12·5	9·2	14·6	8·3	11·0	11·3	10·6	13·0	12·2	10·8	9·8
10	Longest ray of anal ..	7·0	8·4	5·1	10·3	6·0	7·5	7·7	6·9	9·6	8·8	8·2	6.5
11	Length of pectoral ..	7·4	10·7	6·9	12·8	7·1	9·2	10·0	9 3	11·2	10·7	8·6	8·0
12	No. of branched rays in dorsal ..	8	8	8	8	8	8	8	8	8	8	8	8
13	No. of branched rays in anal	5	5	5	5	5	5	5	5	5	5	5	5
14	No. of scales in L.L. ..	37	36	36	37	37	37	37	37	37	35	35	36
15	No. of scales in transverse line above L.L.	5	5	5	5	5	5	5	5	5	5	5	5
16	No. of scales in transverse line below L.L.	6½	6½	6½	6½	6½	6½	6½	6½	6½	6½	6½	6½
17	$\frac{1}{2}$	4·59	4·53	4·55	4·82	5·06	4·33	4·37	4·8	4·55	4·61	4·43	4·3
18	$\frac{1}{3}$	5·6	5·5	5·12	5·17	5·12	5·11	5·2	5·76	5·79	5·88	5·23	6·57
19	$\frac{1}{4}$	5·31	5·1	5·46	5·45	5·18	5·31	5·3	5·32	5·53	5·66	5·03	5·11
20	$\frac{4}{7}$	3·8	3·9	3·41	3·9	3·3	3·53	3·48	3·43	3·5	3·53	2·73	3·46
21	$\frac{\text{1-Caudal}}{2}$, ..	3·59	3·53	3·55	3·82	4·06	3·33	3·37	3·8	3·55	3·61	3·43	3·6
22	$\frac{\text{1-Caudal}}{3}$, ..	4·4	4·3	4·0	4·1	4·13	3·93	4·0	4·57	4·51	4·6	4·05	5·4
23	$\frac{\text{1-Caudal}}{4}$, ..	4·3	4·0	4·26	4·32	4·16	4·08	4·07	4·21	4·32	4·43	3·9	4·0

Discognathus phryne, Annandale.

? 1897. *Discognathus variabilis*, Nikolsky, *Ann. Mus. Zool. Ac. Sci.*, St. Petersburg, II, p. 347.

1899. *Discognathus variabilis*, Nikolsky (? in part), *ibid*, IV, p. 412.

1906. *Discognathus variabilis*, editorial note to Regan, *Journ. As. Soc. Bengal*, II, p. 8.

1919. *Discognathus phryne*, Annandale, *Rec. Ind. Mus.*, XVIII, p. 70, pl. x, fig. 3; pl. xi, fig. 2.

The arrangement and structure of the pharyngeal teeth is very similar to that in *D. adiscus*, but they are a little stouter. We find in two specimens of a large series that small vestigial scales occur on the sides of the abdomen. In these specimens 9½ scales, including the vestigial ones, can be distinguished below the lateral line on each side. We have not found any trace of scales on the dorsal line. Fully formed scales are shorter in proportion than those of *D. adiscus* and differ in being ornamented with radii below as well as above the nucleus. The circular striae are more numerous and less regular and the scale has a much more reticulate appearance. The following are the measurements of a large scale from just above the lateral line:—length 1·8 mm.; breadth 2 mm.; distance of nucleus from base 0·3 mm. The specimens of which measurements are given in the table are from the Pishin district of northern Baluchistan, except No. 6, which is the type-specimen from Seistan.

This species has been generally confused with *D. variabilis*, Heckel, from which it differs, according to the description given by Günther,[1] in the size of the eye as well as in its naked ventral and dorsal surfaces. It is impossible, therefore, to discuss the geographical distribution in detail. *D. variabilis* has been recorded from several localities in Syria, Mesopotamia and eastern Persia. Records from the last district probably refer to *D. phryne*.

D. phryne is, with the exception of *Nemachilus montanus* (McClell.) (not the *N. montanus* of Day), by far the most abundant fish in the small streams of the Quetta and Pishin districts of northern Baluchistan at altitudes between 5,000 and 6,000 feet. It is not found in very rapid water but lives in thickets of Characeae and other algae growing on a muddy bottom. Its food consists mainly of soft filamentous algae. At the Kushdil Khan reservoir it was observed in winter to collect in large numbers in pools into which water of a comparatively high temperature was flowing from underground sources into the outflow. The colour is much darker in very clear than in muddy water. In Seistan the species occurs in irrigation channels and probably (*fide* Nikolsky) in the reed-beds of the Hamun. Several specimens were captured by the members of the Seistan Arbitration Commission in the delta of the Helmand.

[1] Günther, *Cat. Fish. Brit. Mus.*, VII, p. 71 (1868).

Discognathus phryne, Annandale.

Measurements (in millimetres). Number of Fin-rays, Scales and Proportions.

1	Total length (including caudal) ..	53·0	63·3	46·4	55·3	74·7	66·0	70·0	38·0	39·0
2	Length of caudal	12·4	14·4	10·7	12·6	15·0	15·0	12·0	9·0	8·0
3	Greatest depth of body	9·2	12·9	8·8	10·6	12·8	13·2	15·0	8·3	8·5
4	Length of head	10·5	13·2	9·6	11·4	13·8	12·8	13·0	8·1	8·0
5	Width of head	7·9	10·3	6·8	8·1	10·9	9·6	11·0	6·0	6·0
6	Length of snout	4·0	5·4	3·8	4·8	5·0	5·3	5·5	2·8	3·0
7	Diameter of eye	2·2	3·0	2·0	2·3	3·0	2·9	3·3	2·0	2·1
8	Interorbital width	5·0	6·8	4·6	5·1	6·0	5·8	6·8	4·0	4·0
9	Longest ray of dorsal	0·0	12·2	8·0	8·6	11·9	12·5	12·9	7·5	6·1
10	Longest ray of anal	7·8	10·5	7·5	8·6	9·7	9·5	10·0	5·2	5·3
11	Length of pectoral	9·9	11·5	8·0	9·7	11·5	10·4	11·5	8·0	6·6
12	No. of branched rays in dorsal ..	7	7	7	7	6	7	7	7	7
13	No. of branched rays in anal ..	5	5	5	5	5	5	5	5	5
14	No. of scales in L.L.	35	33	33	34	40	35	36	35	35
15	No. of scales in transverse line above L.L.	5½	4½	2½	4½	6½	5½	6½	5½	3½
16	No. of scales in transverse line between L.L. and ventral ..	4½	5½	5½	5½	6½	4½	5½	5½	5½
17	$\frac{1}{2}$	4·27	4·4	4·33	4·37	4·98	4·4	5·81	4·22	4·87
18	$\frac{1}{3}$	5·76	4·9	5·27	5·21	5·83	5·0	4·66	4·57	4·58
19	$\frac{1}{4}$	5·05	4·8	4·83	4·85	5·83	5·15	5·38	4·69	4·85
20	$\frac{4}{7}$	4·77	4·4	4·8	4·95	4·6	4·41	4·03	4·05	3·81
21	$\frac{\text{1-Caudal}}{2}$, ...	3·27	3·4	3·33	3·37	5·98	3·4	4·81	3·22	3·87
22	$\frac{\text{1-Caudal}}{3}$, ...	4·41	3·8	4·05	4·02	4·66	3·86	3·86	3·49	3·64
23	$\frac{\text{1-Caudal}}{4}$, ...	3·86	3·7	3·71	3·74	4·32	4·0	4·5	3·58	3·87

Subfam. *SCHIZOTHORACINAE.*

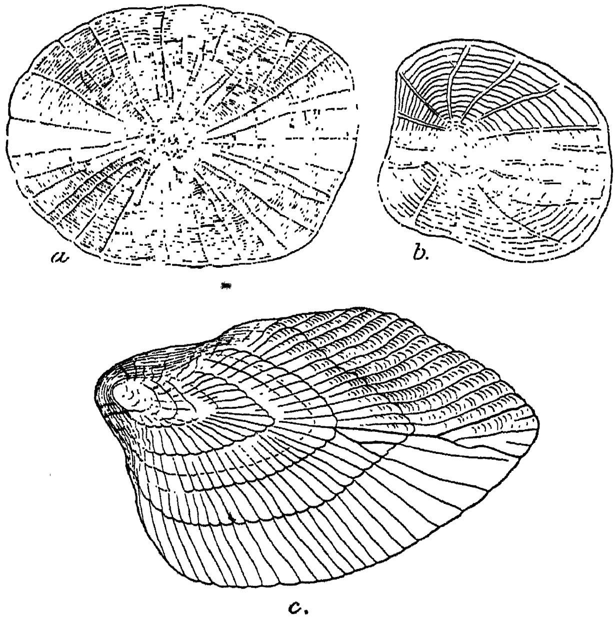
This subfamily is distinguished from the Cyprininae by the Salmonoid facies of the species, their small or degenerate lateral scales and the presence of an anal sheath consisting of folds of skin covered with greatly enlarged scales arranged in two parallel longitudinal rows.

We have already commented on the two most noteworthy features of the Schizothoracinae, their geographical isolation and their superficial resemblance to the Salmonidae. It may be well, however, to state more precisely the characters wherein this resemblance consists, and those whereby the subfamily is linked to the Cyprininae.

The resemblance to the Salmonidae is entirely external. It consists in the graceful but powerful frame of the fish, their small scales and usually silvery, often spotted colouration. The close relationship to the Cyprininae is manifested in the whole structure. One or two important features of agreement may be noted. The air-bladder in both subfamilies is normally very large and is divided into a larger posterior and a smaller anterior region by a transverse

constriction. The pneumatic duct is long and slender and opens into the posterior part of the bladder just behind the constriction. In *Schizothorax zarudnyi* the weberian ossicles closely resemble those of so different-looking a Cyprinid as *Labeo rohita*, to which one of us has recently devoted special study in reference to these bones. The alimentary canal also is closely similar in the two fish.

There is a strong probability that the Central Asiatic subfamily is related to the *Labeo* section of the Cyprininae, from which it has been derived as a result of isolation in mountain rivers flowing rapidly at high altitudes. An important factor,



TEXT-FIG. 5.—Scales of Schizothoracinae.

a. Dorso-lateral scale of *Schizothorax zarudnyi*, × 17½.
b. Dorso-lateral scale of *Schizocypris brucei* (adult specimen), × 37½.
c. Anal scale of *Schizopygopsis stoliczkae* from Siestan, × 17½.

noticed by Stewart[1] in Tibet, is probably the necessity for long and arduous migrations at different periods of life.

The three species (each of a different genus) that live in the lowlands of Seistan are either identical with or very closely related to mountain forms, but, as we have already noted, their isolation in a depression has not produced any very noteworthy structural modification of a general kind, perhaps because it is still too recent.

[1] Stewart, *Rec. Ind. Mus.*, VI, p. 73 (1911).

Genus **Schizothorax**, Heckel.

1888. *Schizothorax*, Herzenstein, *Fische*, p. 96, in *Wiss. Res. Przewalski Central-As. Reis., Zool.* III (2).
1916. *Schizothorax*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, (3), VII, p. 123.

The genus is well represented in the Helmand system, whence Vinciguerra (*loc. cit.*) has given the names of the following five species:—*S. brevis*, McClell., *S. macrolepis* (Keys.), *S. minutus*, Kessler, *S. ritchianus* (McClell.), and *S. zarudnyi* (Nikolsky). There is also in the Indian Museum a mutilated skin from the old collection of the Asiatic Society of Bengal labelled "Schizothorax labiatus, McClell. Helmund R., Afghanistan." The specimen is too imperfect to substantiate the identification, but the species to which it has been assigned is too distinctive to have been readily mistaken. We have thus six species known from this river-system, but except *S. zarudnyi* all these species have been found only in the upper waters at comparatively high altitudes. *S. zarudnyi*, moreover, is so closely allied to *S. intermedius*, McClell., a species common in some parts of the mountains of Afghanistan, that there can be little doubt as to its having originated as an isolated race of that species.

Schizothorax zarudnyi (Nikolsky).

(Plate XV, figs. 1, 2).

1897. *Apiostoma zarudnyi*, Nikolsky, *Ann. Mus. Zool. Ac. Sci.*, St. Petersburg, II, p. 346.
1899. *Schizothorax zarudnyi*, *id.*, *ibid.*, IV, p. 409.

This species is, as we have already stated, very closely allied to *S. intermedius*, McClell.,[1] but the following differential characters are constant in a large series of adult specimens:—

1. The paired fins are much smaller.
2. The branchial isthmus is longer and narrower.
3. The scales are slightly enlarged at the base of all the fins, especially the dorsal and the anal.

Among the races assigned to *S. intermedius* by Herzenstein *S. zarudnyi* comes nearest *affinis*, Kessler (*op. cit.*, p. 113, pl. xiv, fig. 1), but the snout is more pointed and the paired fins smaller and there are no greatly enlarged scales behind the opercular border.

These differences may seem to some ichthyologists of no more than racial value and we have already admitted that we believe *S. zarudnyi* to have originated from *S. intermedius* as a local race. The differences are, however, so constant that we consider it more convenient to regard the Seistan fish as now specifically distinct.

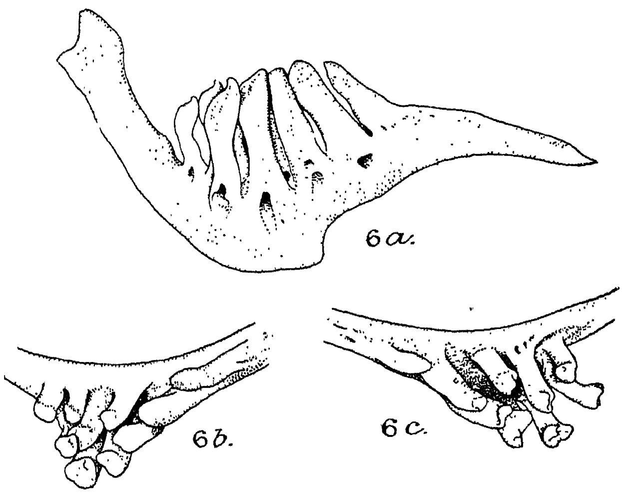
The colouration varies with the environment. In muddy water the back and fins are pale olive-green, the sides faintly

[1] Herzenstein (*op. cit.*, p. 106) does not regard the form identified with McClelland's species by Day as the *forma typica*, but see Günther, *Cat. Fish. Brit. Mus.*

tinged with green and the belly pure white. In the yellow water of the reed-beds the back and sides are much darker, sometimes almost black. A few silvery scales are always present on the back and some adult males have the fins reddish, and dull red specks scattered on the dorsal surface.

The following measurements of a large male and female were taken from freshly killed fish:—

		♀	♂
Total length	.. ..	460 mm.	490 mm.
Length of head	.. ..	92 ,,	106 ,,
Length of eye	.. ..	11·5 ,,	13 ,,
Length of caudal fin	..	74 ,,	74 ,,
Depth of body	.. ..	86 ,,	86 ,,



TEXT-FIG. 6.—Pharyngeal teeth of *Schizothoraz zarudnyi.*

a. Lateral view of lower pharyngeal bone (× 3).
b. c. Internal view of the bones of two sides in another specimen showing lateral variation.

There are great differences in appearance, proportions and lepidosis between young and adults of this species, the chief being that the young are more slender, more silvery, have very much larger dorsal and caudal fins and eyes, and more imperfectly developed scales. In specimens between 56 and 66 mm. long we can detect no scales at all, while in those from 91 to 95 long they are much smaller in proportion than in the adult and are devoid of circular striae.

In specimens up to 123 mm. long the caudal fin occupies about $\frac{1}{5}$ of the total length, while in the adult it occupies only from $\frac{1}{7}$ to $\frac{1}{6}$. In specimens up to 93 mm. long the dorsal fin is considerably deeper than the body; in one 123 mm. long it is almost as deep, but in the adult it is distinctly less deep. The

greatest depth of the body is contained from $8\frac{1}{4}$ to $6\frac{1}{4}$ times in the total length in young fish less than 124 mm. long, while in adults it is contained only from $4\frac{3}{4}$ to $5\frac{3}{4}$ times. In the proportions of the total length without the caudal to the greatest depth the differences are smaller, the figures 6 to $6\frac{1}{2}$ for fish under 67 mm. long, 5 for individuals between 90 and 123 mm. long and from 4 to $4\frac{3}{4}$ in the adult. The proportion between total length and length of head is less different at different ages, and that between head and body (without the caudal) and head is still more uniform, practically no difference existing between young and adult. In length of eye in that of head there is a great difference. In specimens between 56 and 92 mm. long it is roughly from $2\frac{3}{4}$ to $3\frac{3}{4}$ times, in one 123 mm. long $4\frac{3}{4}$ times, in the adult $7\frac{1}{2}$ to 8 times. In the young the spiny dorsal ray is also proportionately more slender and bears relatively much longer denticulations than in the adult. In the young these denticulations have a spiny character.

Schizothorax zarudnyi, Nikolsky.

Measurements (in millimetres). Number of Fin-rays, Scales and Proportions.

	Total length (including caudal)	55·7	65·9	91·3	92·1	122·5	320·3	421·0	285·5	252·0
2	Length of caudal ..	11·4	13·1	18·15	81·4	24·1	47·2	59·1	46·5	43·1
3	Greatest depth of body ..	6·7	8·9	14·4	14·5	19·5	67·0	83·2	56·5	45·3
4	Length of head ..	11·5	14·4	18·8	19·7	25·2	72·6	93·5	64·9	55 4
5	Width of head ..	6·2	7·7	10·12	11·3	14·2	39·8	51·9	35·5	29·6
6	Length of snout ..	3·1	3·5	5·0	6·1	7·8	24·5	30·4	22·7	18·6
7	Diameter of eye ..	3·6	4·3	5·1	5·1	5·3	9·8	12·0	8·1	7·45
8	Interorbital width ..	3·45	4·1	7·1	6·7	8·9	24·8	29·2	20·2	17·6
9	Length of caudal peduncle.									
10	Depth of caudal peduncle ..									
11	Longest ray of dorsal ..	12·25	14·6	19·5	20·4	24·6	47·5	65·3	46·0	41·7
12	Longest ray of anal ..	7·5	8·45	12·6	12·0	17·3	41·1	58·9	37·7	33·8
13	Length of pectoral ..	8·1	8·9	13·6	13·5	18·1	42·2	62·3	36·0	36·8
14	No. of branched rays in dorsal	8	8	8	8	8	8	8	8	8
15	No. of branched rays in anal	5	5	5	5	5	5	5	5	5
16	No. of scales in L.L. ..	..	..	..	..	..	107	110	108	106
17	No. of scales in transverse line above L.L. ..	..	..	35½	..	..	35½	33½	33½	32½
18	No. of scales in transverse line below L.L. ..	..	..	..	..	..	34½	35½	35½	34½
19	$\frac{1}{2}$	4·9	5·0	5·0	5·0	5·08	6·78	7·1	6·14	6 0
20	$\frac{1}{3}$	8·3	7·4	6·34	6·35	6·3	4·78	5·06	5·0	5·5
21	$\frac{1}{4}$	4·85	4·55	4 85	4·7	4·8	4·4	4·5	4·4	4·5
22	$\frac{1}{7}$	3·2	2·82	3·68	3·86	4·75	7·7	7·8	8·0	7·43
23	$\frac{\text{1-Caudal}}{4}$, ...	3·85	3·66	3·88	3·74	3·9	3 76	3·87	3·7	3·77
24	$\frac{\text{1.Caudal}}{2}$, ...	3·9	4·0	3·9	4·0	4·08	5·78	6·6	5·1	4·8
25	$\frac{\text{1-Caudal}}{3}$, ...	6·6	5·9	5·0	5·0	5·	4·07	4·3	4·0	4·6

Schizothorax zarudnyi is a gregarious fish abundant in an adult condition in the pools among the reed-beds of the Hamun-i-Helmand. The roe appeared to be ripe in specimens examined in December. Its food, unlike that of most species of its genus, consists largely if not exclusively of other smaller fish. From the fact that only adults were taken in the Hamun in winter, it is probable that the young make their way up stream in the flood-season. They are extremely abundant in pools left in the beds of effluents of the Helmand or in the desert near these effluents, when the floods subside. It seems probable that the specimens we have examined represent the growth of at least five years and that sexual maturity is not obtained in a shorter period than four years. If this be so, the young of a year old are about 56-66 mm. long; those of two years from 91 to 95 mm., and those of three years about 125 mm.

Both large individuals from the Hamun and young ones from small pools were infested by an immature Trematode, which was encysted in their skin, in the superficial muscles, in the membrane of the fins and on both the outer and the inner aspect of the operculum. The cysts were of a blackish colour and resembled those shown in Herzenstein's figure of *S. altior* (*op. cit.*, pl. xii, fig. 1). We hope that a description of this parasite will be published later.

S. zarudnyi is the only fish commonly caught for food in Seistan. A description of the methods by which it is caught will be found in the appendix to this paper.

Schizopygopsis stoliczkae, Steind.

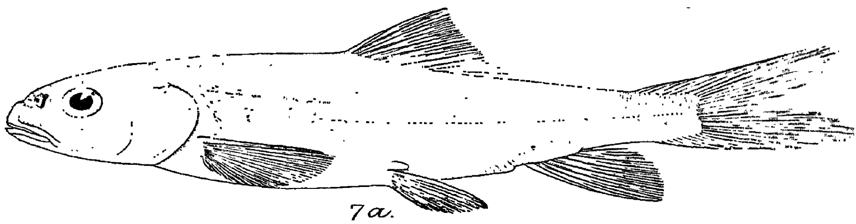
1888. *Schizopygopsis stoliczkae*, Herzenstein, *op. cit.*, p. 191, pl. xvi, fig. 3.

1911. *Schizopygopsis stoliczkae*, Stewart, *Rec. Ind. Mus.*, VI, p. 73, pl. iii, figs. 1, 2 and 3.

Specimens from Seistan, whence we have examined a fairly large series, apparently represent a dwarfed race. The largest we have seen is only 195 mm. long, and even smaller individuals are sexually mature. The two types of head referred to by Stewart (*op. cit.*) as the stoliczkae and the sevewzovi type are both found, without intermediates, in our series, but the former occurs only in two specimens and is not correlated with differences in proportions. We can discover no structural peculiarity in this low-altitude race except that there is a regular double row of large scales extending forwards in continuity with the anal sheath as far as the base of the ventral fins. Traces of a similar forward extension of the sheath are, however, to be found in certain specimens from high altitudes in the large collection from various localities preserved in the Indian Museum. We do not, therefore, consider it advisable to give the Seistan fish a racial name.

The series was collected by the Seistan Arbitration Commission in the delta of the Helmand. The species has a wide range in

the headwaters of streams and rivers on the north side of the Himalayas and Hindu Kush, but except in Seistan is only found at high altitudes.



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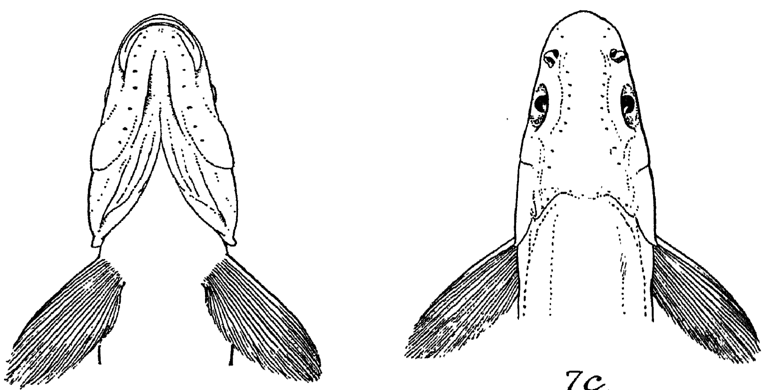


TEXT-FIG. 7.—Adult specimen of Seistan race of *Schizopygops stoliczkae* (reduced in size).

Schizopygopsis stoliczkae, Steind. (Seistan).

Measurements (in millimetres). Number of Fin-rays, Scales and Proportions.

	Total length (including caudal)	52·3	70·2	70·3	179·8	122·6	195·2	141·2	133·2	107·4
	Length of caudal ..	10·1	13·6	14·4	26·3	22·5	32·8	26 9	26·3	20·0
3	Greatest depth of body ..	9·0	12·4	12·4	24·6	23·0	32·4	24·5	25·4	17·3
4	Length of head ..	11·6	15·1	15·3	34·1	26·8	39·6	28·3	30·2	22·4
5	Width of head	5·7	8·3	7·5	20·0	14·9	24·8	17·6	17·0	11·1
6	Length of snout .	3·3	4·7	4·9	9·8	8·2	12·0	9·2	9·5	6·2
7	Diameter of eye ..	3·5	4·2	4·5	6·8	5·2	7·8	6·2	6·0	5·2
8	Interorbital width ..	3·6	5·0	5·0	9·8	8·1	12·5	8·6	10·0	7·2
9	Length of caudal peduncle.	7·2	12	..	20·0	16·2	23·0	9·8	17·1	..
10	Depth of caudal peduncle.	3·0	6·0	..	8·8	7·0	10·0	4·3	8·0	..
11	Longest ray of dorsal ..	9·3	11·5	12·0	25·4	19·3	34·2	25·0	23·0	16·0
12	Longest ray of anal ..	6·6	9·2	8·2	24·6	18·2	29·3	24·0	24·1	15·4
13	Length of pectoral ..	7·1	9·5	10·0	23·0	18·1	31·5	22·7	22·0	15·8
14	No. of branched rays in dorsal	7	7	8	8	8	8	8	7	8
	No. of branched rays in anal	5	5	5	5	5	5	5	5	5
16		5·0	5·16	4·9	6·9	5·45	5·95	5·25	5·05	5·37
17	$\frac{1}{3}$	5·8	5·6	5·67	7·3	5·33	6·02	5·75	5·23	6·2
18		4·5	4·65	4·6	5·27	4·6	4 9	5·0	4·41	4·71
19		3·3	3·6	3·4	5·0	4·6	5·07	4·56	5·3	4·3
	1-Caudal / 4	4·1	4·1	3·88	5·83	4·4	4·95	4·25	4·05	4·37
	$\frac{\text{1-Caudal}}{2}$,	4·66	4·56	4·5	6·2	4·35	5·09	4·66	4·2	5·05
22	$\frac{\text{1-Caudal}}{3}$,	3·62	3·74	3·65	4·5	4·03	4·1	4·03	3·54	3·9
23	$\frac{9}{10}$	2·4	2·0	..	2·27	2·3	2·3	2·25	2·13	..

Schizocypris, Regan.

1914. *Schizocypris*, Regan, *Ann. Mag. Nat. Hist.* (8), XIII, p. 262.

As Mr. Regan's description of the genus is very short, it may be redescribed as follows :—

Schizothoracinae with an inferior mouth, which is broad, transverse and protrusible. The snout projects beyond the mouth. The integument of the upper jaw is thin and adherent and there is no labial fold. The lower jaw is also covered with thin adherent integument. It is prominent but not very sharp and has a spatulate appearance from below. The barbels are absent or vestigial. The scales are confined to the sides and those of the scapular region are not greatly enlarged; those of both scapular and lateral regions are subcircular with radii well developed both above and below the nucleus and completely surrounded by circular striae, which are interrupted by the radii; the anal sheath is well developed. The dorsal fin is moderate, with 8 unbranched rays in the type-species; the last undivided ray is bony and denticulate. The form of the

body is graceful, somewhat compressed, but with a rounded belly. The caudal peduncle is distinct. The pharyngeal teeth are broad and differ from those of *Schizothorax*, in possessing a flat tip; the dental formula is 2·3·4|4·3·2.

In general facies this genus resembles *Schizopygopsis*, from which it is distinguished by the presence of small scales on the sides and the absence of large scales from the scapular region. It differs from *Schizothorax* in the structure of its mouth and pharyngeal dentition and in having the abdominal surface naked.

Schizocypris brucei, Regan.

(Plate XV, fig. 3).

1914. *Schizocypris brucei*, Regan, *loc. cit.*, fig. B.

The specimens before us are young and closely resemble immature specimens of *Schizothorax zarudnyi*, with which they were confused in the field, in appearance. Allowing for parallel differences in proportions we see no reason to regard them as distinct from the type-species of the genus, but as these differences exist, we think it best, in order to avoid any possibility of confusion, to describe our specimens in detail. The largest of them is nearly 48 mm. long without the caudal.

The dorsal profile is considerably and regularly arched, the ventral profile slightly convex. The greatest depth of the body is contained from $4\frac{1}{2}$ to $4\frac{3}{4}$ times in the total length without the caudal. The caudal peduncle in the largest specimens examined is twice or nearly twice as long as deep. The head is large, its length being contained from $3\frac{3}{4}$ to 4 times in the total length without the caudal. The snout is short and bluntly rounded and appears somewhat swollen in lateral view. It is slightly longer than the eye and less than half as long as the part of the head behind the eye. The upper surface of the head is flat. The nostrils are situated close to the eye, a little in front of it. The eye is large, its length being contained 3 to $3\frac{1}{2}$ times in that of the head and about $1\frac{1}{2}$ times in the interorbital width. The arc of the mouth is very wide and the posterior end of the maxilla is situated in front of and considerably below the eye. The fins are large and the dorsal is higher than the body; its margin is straight but slanting. The pectoral is shorter than the head. The scales appear to be fully developed and those of the lateral agree in structure with those of the scapular region. They are slightly broader than long, slightly sinuate at the base and differ markedly from those of *Schizothorax* in that the nucleus is situated at about a third the length of the scale from the free margin. The circular striae are about 7 in number. The radii are widely spaced and are considerably longer below than above the nucleus. The scales of the scapular region are of moderate size. They become gradually smaller from before backwards. Those on the upper parts of the sides, bordering the rather narrow naked dorsal region, are

very small, but those at the base of the dorsal fin are a little larger. Those near the lateral line are of intermediate size. Towards the tail all the scales are poorly developed and hard to distinguish. The lateral line runs along the middle of the caudal peduncle, then slopes gradually downwards, proceeds along the body well below the middle and finally slopes upwards just behind the head, along the top of which it runs to the tip of the snout. The colour is bluish above and silvery on the belly and sides There are sometimes a few small black spots on the latter.

Schizocypris brucei, Regan.

Measurements (in millimetres). Number of Fin-rays and Proportions.

1	Total length of body (caudal excluded)	45·2	47·8	42·4	42·7	32·5	23·8
2	Greatest depth of body ..	9·6	10·5	9·4	9·7	7·1	4·7
3	Length of head	11·6	12·2	11·2	11·0	8·5	6·3
4	Width of head	7·1	7·8	7·0	7·0	5·0	3·3
5	Length of snout	3·8	4·0	3·7	3·1	2·5	1·7
6	Diameter of eye	3·25	3·6	3·2	3·3	2·7	1·8
7	Interorbital width	4·9	5·0	4·3	4·2	3·8	2·5
8	Longest ray of dorsal	12·1	11·3	10·4	11·7	9·3	6·25
9	,, ,, ,, anal	8·0	8·6	7·6	8·2	5·6	4·35
10	Length of pectoral	9·0	9·1	8·3	8·1	5·8	4·5
11	No. of branched rays in dorsal ..	8	..	8	8	8	8
12	,, ,, ,, ,, ,, anal ..	5	5	5	5	5	5
13	Length of caudal peduncle ..	8	7·9	6·8	7·0	6·5	5·0
14	Depth of caudal peduncle ..	3·8	4·5	4·0	4·0	2·7	1·7
15	$\frac{1}{2}$	*4·7*	*4·55*	*4·51*	*4·4*	*4·57*	*4·21*
16	$\frac{1}{3}$	*3·9*	*3·91*	*3·78*	*3·88*	*3·82*	*3·77*
17	$\frac{3}{6}$	*3·57*	*3·39*	*3·5*	*3·33*	*3·15*	*3·5*
18	$\frac{13}{14}$	*2·1*	*1·75*	*1·7*	*1·75*	*2·4*	*2·94*

The species was described from Waziristan in the eastern district of the great mass of mountains that occupies northern Baluchistan and a great part of Afghanistan. A few specimens, the longest of which is 48 mm. long without the caudal, have been found among large numbers of young *Sehizothorax zarudnyi* and of *Discognathus adiscus* from the following localities:—a small pool connected in the flood-season with an effluent of the Helmand in the desert a few miles south of Nasratabad; pools in the dry bed of the Randa stream in the same district a few miles N.E. of the ruined city of Jellalabad ; a still, reedy channel leading from the Hamun-i-Seistan on the road between Lab-i-Baring and Nasratabad. The largest specimens, which were alone distinguished at the time, are from the last locality. Their fin-rays were extremely brittle and unfortunately the caudal was broken in all those obtained but one. These specimens were collected in November and December, 1919.

Since drawing up this description we have been able to compare our specimens with one of the types of the species, received in exchange by the Z.S.I. through the courtesy of Mr. Tate Regan and the Trustees of the British Museum. Though the proportions

are naturally different we can find no structural difference. We have now no doubt that the specimens are specifically identical.

Family COBITIDAE.

The Loaches, which share with the Trout Carp (Schizothoracinae) the waters of the Central Asiatic plateau, are represented in those of Seistan by two genera, both of which also occur in Central Asia. One of these genera, *Nemachilus*, has a wide range in the Palaearctic and Oriental regions. Its single representative in Seistan is apparently dimorphic and occurs also in the headwaters of all the rivers immediately north and east of the great Himalayan range and the Hindu Kush. This species is *N. stoliczkae* (Steind.), of which we regard *N. stenurus*, Herz. as a dimorph. Apart from Seistan, *N. stoliczkae* is found only at high altitudes.

The other Cobitid genus that occurs in Seistan is here described as new. It is closely related in structure to *Nemachilus* but possesses one peculiarity, a soft dorsal fin, which differentiates it from most other Cyprinoidea and, together with its peculiar facies, constitutes it an apparent link between the Cobitidae and the Siluroidea. We discuss the structure, function and homology of this fin below. The genus, though strangely enough the soft fin has not been recognized as such hitherto, occurs also in Turkestan, and it is possible that Persian species assigned by Nikolsky to *Nemachilus* may also belong to it. The new genus is represented in Seistan by two species.

Genus **Nemachilus**, v. Hasselt.

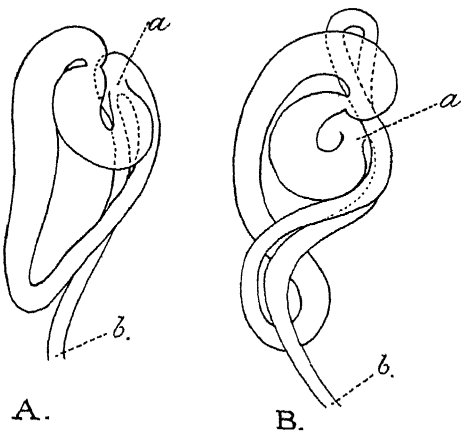
The one Seistani species (*N. stoliczkae*) of this genus belongs to a little group of Central Asiatic forms in which the Tibetan *N. lhasae*, Regan, and *N. yarkandensis*, Day, from Turkestan must also be included. This group is distinguished by the elongate form of the body and especially by that of the caudal peduncle. The fins are large, the eyes small, and scales are as a rule absent. The ventral surface is rounded and not specially adapted for purposes of adhesion. These fish are inhabitants of rapid but turbid streams, as a rule at very high altitudes. We have unfortunately no information as to the circumstances in which the Seistan form occurs.

Nemachilus stoliczkae (Steindachner).

1866. *Corbitis stoliczkae*, Steindachner, *Verh. Zool. bot. Ges. Wein.*, XVI, p. 793, pl. xiv, fig. 2.
1878. *Nemachilus stoliczkae*, Day, *Fishes of India*, II, p. 620, pl. clv, fig. 10.
1888. *Nemachilus stoliczkae*, Herzenstein, *op. cit.*, p. 14, pl. i, figs. 2-5; pl. iii, figs. 1-4; pl. vii, figs. 3-4; pl. viii, fig. 12.
1888. *Nemachilus stenurus*, *id.*, *op. cit.*, p. 64, pl. i, fig. 1.
1906. *Nemachilus stenurus*, editorial note to Regan, *Journ. As. Soc. Bengal*, II, p. 8.
1908. *Nemachilus stoliczkae*, Lloyd (in part), *Rec. Ind. Mus.*, II, p. 341.

1916. *Nemachilus stoliczkae,* Vinciguerra, *Ann. Mus. Stor. Nat. Genova,* XLVII, p. 146:
1916. *Nemachilus stenurus, id., op. cit.,* p. 148.

The Indian Museum possesses a large number of specimens of this species from Tibet, northern Kashmir, Turkestan and Seistan. Among those identified by various ichthyologists as *N. stoliczkae* we find, however, four forms, one of which is without doubt specifically distinct. This is *N. lhasae*, Regan, from Tibet; we give measurements of a series of specimens but need not discuss the species further. The remaining three forms that have hitherto been placed together under the name *Nemachilus stoliczkae* in India belong in our opinion to that species and are identical respectively with the typical form (of which we have a topotype), the variety *leptosoma* of Herzenstein and *N. stenurus* of the same author. All



TEXT-FIG. 8.—Alimentary canal of *Nemachilus stoliczkae* from Seistan.
A. From specimens of *stoliczkae* type.
B. From specimens of *stenurus* type
a and *b* = cut ends of alimentary canal.

the specimens from Seistan were identified by Mr. Tate Regan as *N. stenurus*, but we find among them two distinct forms, one of which we regard as identical with *leptosoma*, while the other we retain under the name *stenurus*, which, however, we do not accept as specific.

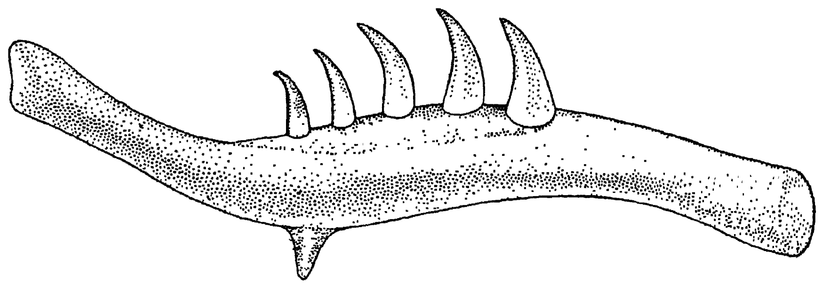
The first specimens we examined were those from Seistan labelled *N. stenurus*. The existence of two forms among them was visible on inspection and was on the whole confirmed by measurements. There were seven specimens in this series, as to four of which we had no hesitation in accepting Mr. Regan's identification. Of the remaining three specimens, one was an adult female, one a breeding male and one very young. The male agrees well with Herzenstein's figures of *N. stoliczkae* var. *leptosoma*, the female rather with that of var. *productus*. As the main difference between these two supposed varieties and *stenurus* lies

in their broader and thicker caudal peduncles, and this was precisely the difference noted in our specimens, we assigned them provisionally to *N. stoliczkae* var. *leptosoma*, in which it seemed necessary to include the var. *productus*.

On dissection we found that the alimentary canal of one of these specimens agreed with Herzenstein's figure (*op. cit.*, pl. viii, fig. 12) of that of *N. stoliczkae*. The alimentary canal of an individual of the same lot but belonging to the *stenurus* type differed considerably, as may be seen from fig 8.

There seemed, therefore, at this stage in our investigation to be good grounds for considering the two forms, though occurring together, as specifically distinct. On examining the other specimens in the collection we found two (from a stream running into the Ram-Tso lake in Tibet) that clearly belonged to the *stenurus* type. These had been confused with *N. lhasae*, which had also been assigned to *N. stoliczkae*. We also found two specimens from Leh belonging to this (the true *stenurus*) type.

We dissected one of the two Tibetan and one of the Ladakh



TEXT-FIG. 9.—Pharyngeal teeth of *Nemachilus stoliczkae* from Seistan (×25).

specimens of *stenurus*—to find that in both the alimentary canal agreed with that of the individual of the *leptosoma* type from Seistan. Subsequent investigations proved that the structure of both types was variable in this respect. The one constant difference that we could find between *stoliczkae* (s.l.) and *stenurus* lay in the proportions of the caudal peduncle, and even these varied, as may be seen from our table of measurements, within wide limits. It does not, therefore, seem justifiable any longer to maintain *stenurus* as specifically distinct. The difference is neither sexual nor racial, but appears rather to be a true instance of dimorphism affecting both sexes.

If this be so, the apparently discontinuous range of *N. stenurus*, which is recorded only from the mountains near the source of the Yangtse, from Scardo north of Kashmir and from Seistan, becomes explicable, for *N. stoliczkae* has the widest range of any member of its family in Central Asia.

Another point to be considered is the status of the different varieties of *N. stoliczkae* recognized by Herzenstein (*loc. cit.*). We find it difficult in the large collection before us to assign some

of the specimens definitely to any one variety and considerable individual variability undoubtedly exists. Some specimens from northern Kashmir and Turkestan, however, as well as those from Seistan certainly belong to the var. *leptosoma.* Unfortunately we have no very precise data as to their *provenance.*

Nemachilus stoliczkae (Steind.) (Seistan).

Measurements (*in millimetres*). *Number of Fin-rays, and Proportions.*

		Stenurus type.			*Stoliczkae type.*		
		♂	♂	♀	♀	♂	♂
1	Total length (including caudal) ..	105·2	75·0	90·7	109·1	94·6	80·0
2	Length of caudal	16·1	12·4	16·0	16·7	15·3	14·7
3	Greatest depth of body.. ..	13·3	10·1	13·6	13·2	12·5	10·0
4	Length of head	19·2	15·6	17·0	19·3	17·4	14·5
5	Width of head	13·4	8·8	10·3	11·5	10·5	9·3
6	Length of snout	9·2	6·6	9·0	7·8	7·4	6·5
7	Diameter of eye	4·0	2·9	3·2	3·5	3·4	2·9
8	Interorbital width	5·2	3·9	4·0	4·8	4·7	4·1
9	Length of caudal peduncle ..	21·7	15·5	15·4	21·7	15·1	12·6
10	Depth of caudal peduncle ..	2·8	2·4	2·9	6·1	5·2	4·3
11	Longest ray of dorsal	15·0	12·3	15·5	14·4	13.8	12·3
12	Longest ray of anal	14·1	10·5	12·8	12·6	12·0	9·8
13	Length of pectoral	16·2	13·3	15·2	15·0	14·5	12·2
14	No. of branched rays in dorsal ..	8	8	8	8	8	8
15	No. of branched rays in anal ..	5	5	5	5	5	5
16	$\frac{1}{2}$	*6·53*	*6·04*	*5·67*	*6·53*	*6·18*	*5·4*
17	$\frac{1}{3}$	*7·91*	*7·42*	*6·81*	*8·33*	*7·56*	*8·0*
18	$\frac{1}{4}$	*5·47*	*4·8*	*5·33*	*5·65*	*5·44*	*5·51*
19	$\frac{4}{7}$	*4·8*	*5·31*	*5·31*	*5·51*	*5·11*	*5·0*
20	$\frac{1\text{-Caudal}}{2}$, ...	*5·53*	*5·04*	*4·67*	*5·53*	*5·18*	*4·44*
21	$\frac{1\text{-Caudal}}{3}$, ...	*6·7*	*6·19*	*5·49*	*7·0*	*6·35*	*6·53*
22	$\frac{1\text{-Caudal}}{4}$, ...	*4·64*	*4·03*	*4·39*	*4·78*	*4·55*	*4·5*
23	$\frac{9}{10}$	*7 75*	*6·46*	*5·31*	*3·55*	*2·86*	*2·93*

Nemachilus lhasae, Regan (Tibet).

Measurements (in millimetres). Number of Fin-rays, and Proportions.

1	Total length (including caudal)	86·2	78·0	76·8	55·0	84·5	69·0
2	Length of caudal ..	13·2	11·2	13·2	9·2	14·0	12·0
3	Greatest depth of body	11·0	10·0	9·3	7·0	11·2	9·8
4	Length of head ..	17·0	16·0	16·5	11·6	17·0	15·5
5	Width of head ..	10·3	8·6	8·2	6·2	10·8	9·5
6	Length of snout ..	7·0	6·2	6·3	4·6	6·6	7·0
7	Diameter of eye ..	4·4	4·1	4·0	2·8	3·8	3·5
8	Interorbital width ..	4·0	4·1	4·0	2·8	4·6	3·3
9	Length of caudal peduncle	17·0	17·0	15·0	12·0	17·0	13·6
10	Depth of caudal peduncle	2·7	2·8	2·6	2·0	2·7	2·3
11	Longest ray of dorsal ..	14·0	13·0	14·0	10·4	16·0	12·2
12	Longest ray of anal ..	10·0	9·3	10·5	7·5	10·6	8·8
13	Length of pectoral ..	14·0	11·5	11·3	10·8	14·3	12·0
14	No. of branched rays in dorsal	8	8	8	8	8	8
15	No. of branched rays in anal	5	5	5	5	5	5
16	$\frac{1}{2}$	*6·53*	*6·96*	*5·81*	*5·97*	*6·35*	*5·75*
17	$\frac{1}{3}$	*7·83*	*7·8*	*8·25*	*7·85*	*7·5*	*7·04*
18	$\frac{1}{4}$	*5·07*	*4·87*	*4·65*	*4·74*	*4·94*	*4·45*
19	$\frac{4}{7}$	*3·86*	*3·9*	*4·1*	*4·14*	*4·47*	*4·43*
20	1-Caudal	*5·53*	*5·96*	*4·81*	*5·97*	*5·35*	*4·75*
21	3	*6·63*	*6·68*	*6·83*	*6·54*	*6·29*	*5·81*
22	$\frac{\text{1-Caudal}}{4}$,	*4·3*	*4·17*	*3·85*	*3·95*	*4·14*	*3·67*
23	$\frac{9}{10}$.	*6·3*	*6·07*	*5·77*	*6·0*	*6·3*	*5·91*

Genus **Adiposia** nov.

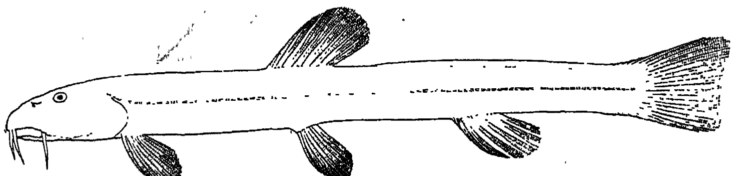
The genus may be described as follows :—

A genus of Cobitidae consisting of elongate species often of large size, with or without minute scales on the body, without a suborbital spine, with six barbels, *with an elongate band-shaded soft fin between the dorsal and the caudal.* The head is relatively small, flattened and Siluroid in appearance; the eye small, dorsal in position, of an elongate oval form, and surrounded by a free circular fold; the nostrils are situated close together in front of the eye, the posterior nostril being elongate and slit-like; the mouth is large, ventral in position and provided with tumid lips and with 6 barbels. The fins are relatively small and all the rays cartilaginous. The lateral line is well developed and extends all along the middle of the body in a straight or sinuous line. The pharyngeal bones are delicate and bear a single series of sharp slender teeth. The air-bladder, which is entirely enclosed in bone, is dumbell-shaped and transverse and consists of a pair of spherical lateral chambers connected by a tube. It possesses a short,

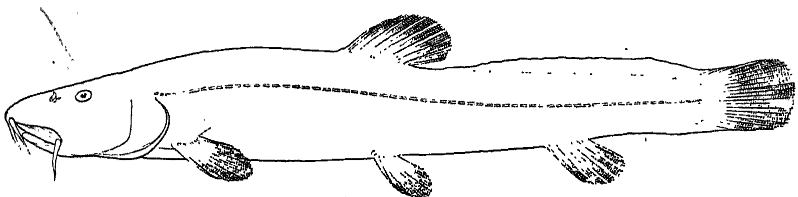
slender, tubular diverticulum, which is directed backwards from the transverse tube and ends in a vesicle.

Type-species: *Nemachilus macmahoni*, Chaudhuri.

Three species are known definitely to belong to this genus namely *Nemachilus longicauda*, Kessler,[1] *N. rhadinaeus*, Regan[2] and *N. macmahoni*, Chaudhuri,[3] but the most important generic character (the adipose fin), which is by no means conspicuous in badly preserved specimens, has escaped the notice of most ichthyologists. Chaudhuri in his description of *A. macmahoni* refers to it as a fold of skin, but sections show that it is a structure of much more definite nature. We give a full description of it below.



10 *a*.



10 *b*.

TEXT-FIG. 10.—Type specimens of Seistan species of *Adiposia* (reduced).
a. A. rhadinaea (Regan).
b. A. macmahoni (Chaudhuri).

Two of the three species at present known are from Seistan, the third (*A. longicauda*) from Turkestan.

The soft dorsal fin of Adiposia. This fin has the form of a ridge arising a short distance behind the dorsal and extending to the base of the caudal, in which it finally disappears. The anterior margin slopes upwards and backwards gradually, the posterior extremity is ill-defined. Its relative height varies in different species, and even to some extent in different individuals of the same species. In *A. macmahoni* the height may be as much as $\frac{2}{5}$ of that of the caudal peduncle in well-preserved specimens, but in shrivelled

[1] Kessler, "Pisces" in Fedtschenko's "*Reise in Turkestan,*" p. 38, pl. vi, 22, 23 (1874).
[2] Regan, *Journ. As. Soc. Bengal*, II, p. 8 (1906).
[3] Chaudhuri, *Rec. Ind. Mus.*, III, p. 341 (1909).

specimens it is considerably less. The fin is strongly compressed from side to side.

In vertical section an external wall and an internal core can be distinguished. The former is further divided into two regions, an external epithelial and an internal connective-tissue region. The epithelial region, which is similar to the integument of the body, consists mainly of several layers of small, more or less flattened and rectangular cells with well-defined cell-walls and relatively large oval nuclei. Among these are scattered numerous large ampulliform gland-cells. In the lower parts of the fin the gland-cells are situated mostly at the base of this region and constitute almost a separate layer, the small epithelial cells between them being somewhat elongated by pressure. Towards the crest of the ridge, however, there is no definite separation of the kind and the gland-cells are often on the surface.

The inner region of the outer wall consists of fibrous connective tissue, the fibres of which run completely round the fin in a horizontal and vertical direction, separating it below from the dorsal muscles, over which the epithelial layer does not extend. This region is similar to that lying immediately below the epithelial covering of the body.

In the region of the connective tissue and between it and that of the epithelium numerous longitudinal blood vessels can be easily distinguished. They have a narrowly oval outline in vertical section, with the longer axis vertical in the side-walls, and transverse above the dorsal muscles.

Just inside the region of connective tissue of the side-walls there are a number of small lucunae containing granular masses of black pigment. These have no definite walls.

The central core consists of a mass, conical in vertical section, of highly vacuolated tissue. The vacuoles are of relatively large size and irregular shape. No cell-walls can be distinguished but the spaces are surrounded by deeply staining protoplasm containing numerous minute oval nuclei. The contents of the vacuoles are gelatinous and appear to have a reticulate structure when stained with haemotoxylin. This structure, however, may be an artifect.

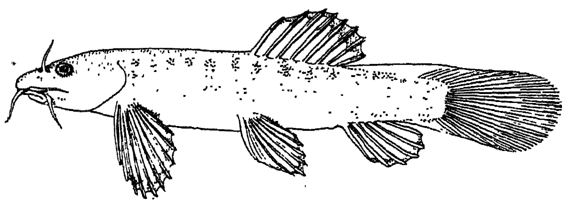
Comparatively large blood-vessels make their way obliquel upwards from the body into the central core of the soft fin a intervals and ramify in it. We have not been able to trace an connection between them and the smaller lateral and bas vessels.

In the upper part of the fin irregular fibrous strands, probably representing degenerate ceratotrichia, can be distinguished in the centre of the core. They run in a vertical direction, and are connected with a kind of reticulation formed by the walls of the vacuoles.

In external appearance the adipose fin of *Adiposia* closely resembles that of the soft fin of the Siluroid genus *Amblyceps*, which is assigned by recent authors to the family Sisoridae. We

have not been able to examine specimens of this genus preserved for histological investigation, but we have cut sections of the fin in a species of the related genus *Glyptosternum*. We have also sectioned the primitive dorsal fold in post-larval specimens of a species of *Nemachilus*. Before discussing the significance of the structure in *Adiposia*, we must give a brief account of that found in these other fish.

In young specimens of *Nemachilus evezardi* recently obtained by Major R. B. Seymour Sewell at Khandalla and easily recognized by the presence of a nasal barbel [1], the primitive dorsal fin-fold remains in a very interesting condition until the fish is at least 1 cm. long. The dorsal fin of the adult is already well-developed and has its rays fully formed, but behind it the fold persists, extending into the caudal. The anterior extremity of this vestige of the fold slopes gradually upwards and backwards. Externally the whole structure has a very close resemblance to the same parts of *Adiposia*. Indeed, the only differences to be noted



TEXT-FIG. 11.—Young of *Nemachilus evezardi* 1 cm. long showing dorsal fold.

on a superficial examination are that the ceratotrichia are well developed, especially in the posterior part of the fold, and that the fold also extends forwards from the caudal on the ventral surface.

We have examined a large number of species of *Nemachilus* from both mountainous regions and comparatively level country for traces of the persistence of this condition. In all we find a short, compressed pad, clearly representing the posterior part of the fold, at the base of the caudal fin both above and below. In some this fold persists as a ridge to a comparatively late age. In *N. savona* it is in this condition in a specimen 39 mm. long.

In vertical sections of the dorsal fold in a young *N. evezardi* about 1 cm. long we find the structure essentially similar to that of the soft fin of *Adiposia*, but, as might be expected, the tissues are less differentiated. The outer wall is thinner, its gland-cells are more numerous and its epithelial cells less distinct. The layer

1 Jordan and Fowler regard this as a generic character but we are not pre- [illegible] to accept their view.

of fibrous connective tissue is thin and incompletely differentiated and is not continuous across the dorsal muscles at the base. The central core has a more fibrous structure with smaller, ill-developed vacuoles. The blood-vessels are few and poorly developed.

We have cut sections also, as already stated, of the adipose fin of a species of *Glyptosternum* (Sisoridae) from the base of the Nilgiri Hills for comparison. It would be out of place in the present context to discuss the structure of this fin in detail. We may say here, however, that an inner core of highly vacuolated tissue, closely resembling that found in the fin of *Adiposia*, occupies the centre of the structure and that its wall consists of two regions, the structure of both of which differs considerably from that of the homologous regions in *Adiposia*. Our figures (pl. xvi, figs. 5 and 6) and the explanation of them will illustrate the differences sufficiently for our present purpose. These differences are so considerable that there can be little doubt that the adipose fin of *Adiposia*, though (like that of the Siluridae) derived from the posterior part of the primitive dorsal fold, has originated independently, probably in correlation with the assumption of the habit of burrowing in the mud of bodies of water liable to desiccation, and there aestivating or hibernating until the return of the flood season.

It seems to be clear, therefore, that the soft fin [1] of *Adiposia* is a highly specialized structure, but that it is fundamentally homologous with the posterior precaudal part at the primitive dorsal fold.

The function of this fin in *Adiposia* is possibly a double one. It may act as a reserve food-supply for a voracious fish that must occasionally be deprived of food for considerable periods. It probably is also an accessory breathing organ, to judge from its copious blood-supply, of use when the fish is buried in damp mud.

Relationships of Adiposia.—From what has been said above it is, we believe, clear that *Adiposia* is closely related to *Nemachilus*. Its resemblance to the Siluroidea is probably more apparent than real, being due mainly to the persistence, doubtless secondary, of a post-larval character and its slight modification. We have no reason to think that *Adiposia* is an extremely primitive form, as would be the case if the persistence of this one juvenile character were accepted as evidence of direct affinities with the ancestral forms of both the Cyprinoidea and the Siluroidea, for, indeed, the dorsal fin-fold is an ancestral feature common to all fishes, and even to other groups of primitive vertebrates. In all fish with a dorsal fin of any kind part of it persists and the adipose fin of Salmonidae is not supported by other evidence as proof of close affinity with the Siluroidea.

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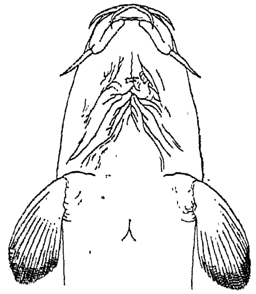
[1] A recent investigation of well-preserved specimens of *Acanthophthalmus pangia* proves the existence of a similar structure in that species.

Adiposia macmahoni (Chaudhuri).

(Plate XV, fig. 4; Plate XVI, figs. 1 & 2.)

1909. *Nemachilus macmahoni*, Chaudhuri, *Rec. Ind. Mus.*, III, p. 341.

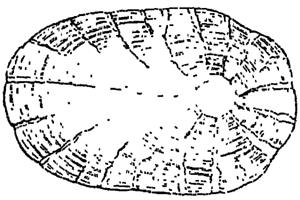
As Dr. Chaudhuri's description was based on a single specimen not in the best condition and bleached by exposure to light, we give a fuller account of the species here, based on numerous well-preserved examples.



TEXT-FIG. 12.—Lower surface of head of *Adiposia macmahoni* (× ¾).

The fish is one of the largest of its family, attaining a length of over 27 cm. and has an extremely Siluroid appearance owing to its elongate form, broad, flattened head, and small, dorsal eyes. The dorsal profile immediately behind the head is somewhat convex, but both the dorsal and ventral profiles behind the dorsal fin are nearly straight and parallel and the greatest depth is contained $6\frac{2}{5}$ to a little over 8 times in the total length without the caudal, $7\frac{1}{2}$ to nearly 10 times with the caudal. The head is depressed considerably below the profile of the back and its upper surface slants downwards from behind almost in a straight line; it is broad and flat and its length is contained from $4\frac{1}{2}$ to 5 times in the total length without the caudal. The specimens in our series seem to fall into two groups, in one of which the head is less flat and narrower than in the other. Possibly the difference is sexual, for it seems to be correlated with slight differences in the form of the vent, but the sexual organs are quite undeveloped in the fish recently collected, while they have been removed from the type. The length of the eye is contained $5\frac{2}{5}$ to $8\frac{2}{5}$ times in that of the head, but is relatively much less in the adult than in the young. The pupil is nearly in the midddle of the head. The nostrils are nearer to the eye than to the tip of the snout. The barbels are subequal in length, which varies considerably; the two anterior pairs usually reach to a vertical line from the nostrils if pressed backwards, and the posterior pair to one from the anterior border or middle of the eye. The cleft of the mouth does not reach as far back as the front of the eye. The anterior lip is continuous and minutely tubercular, the posterior lip smooth and widely interrupted in the middle line. The branchial isthmus is short and narrow. The chest and abdomen are flat. The pectoral fin, which is rounded at the tip, is much shorter than the head. The dorsal in quite young fish is higher than the body, but in the adult lower; it is situated nearer the tip of the snout than the base of the caudal. The ventral and anal [illegible] the caudal of moderate length,

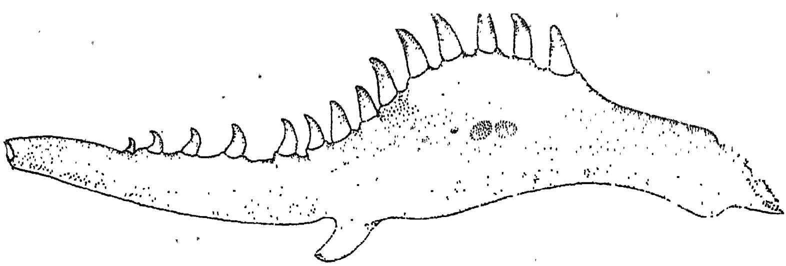
rounded, truncate or slightly emarginate at the tip. The caudal peduncle is compressed and from $1\frac{3}{5}$ to $2\frac{1}{2}$ times as long as deep.



TEXT-FIG. 13.—Scale of *Adiposia macmahoni* (× 35), from base of dorsal fin.

We can detect no scales on the young fish, but in the adult minute but well-developed scales are present on the sides of the posterior part of the body. They are longitudinally oval in form and have the nucleus near the base. Their sculpture consists of numerous coarse radii and circular striae, both of which occur all round the scale. The scales are rather widely separated and buried in the skin. They appear to be much less conspicuous than in *A. longicauda*, Kessler.

The following note on the colouration was made from living fish :—" The loach is variable in colour ; it is usually very pale olivaceous, fading to silvery white on the belly and irregularly spotted on the head and upper part of the body with a darker shade. In some individuals the head and body are pale yellowish without markings or with a faint marbling. All the fins are tinged with dull red, which is more intense on the caudal than on the others, and are as a rule obscurely marked with small dark spots. There is always a narrow dark vertical stripe at the base



TEXT-FIG. 14.—Pharyngeal teeth of *Adiposia macmahoni* (× 7).

of the caudal on its peduncle." This description, which refers to young and half-grown fish, applies equally well to specimens carefully preserved in formalin and spirit, except that the olivaceous and yellowish tints have faded and the reddish colour disappeared from the fins.

The pharyngeal bones have the form normal in the Cobitidae, but are perhaps a little straighter than usual. There are about 12 teeth arranged mainly on an almost semicircular prominence. In the adult they are all shorter than the smallest diameter of the bone and (except those at the lower end of the series, which are very small) almost subequal in length, those in the middle of the prominence being slightly enlarged. In the young the central teeth are relatively longer.

The posterior diverticulum of the air-bladder is longer than the diameter of the transverse tube from which it originates and its vesicle is longer than the stalk.

Type-specimen No. F 1222/1 (*Z.S.I.*).

The type-specimen was obtained by the Seistan Arbitration Commission in the delta of the Helmand. Young and half-grown fish were found in great abundance in small pools in the bed of the Randa stream near the ruined city of Jellalabad some 12 miles north of Nasratabad, at the end of November. They were buried at a depth of some inches in the mud at the bottom of the pools and seemed to be in a healthy and active condition, although the water was extremely foul and most of the Cyprinidae in the pools were dead or dying. The species is evidently predaceous, for remains of other fish were found in the stomach, and also those of a may-fly larva (*Palingenia* [1]) that occurred in large numbers with it. Other members of the same association were the crab *Potamon* (*Potamon*) *potamios gedrosianum* and the molluscs *Corbicula fluminalis* and *Lamellidens marginalis rhadinaeus*.

Adiposia rhadinaea (Regan).

1906. *Nemachilus rhadinaeus*, Regan, *Journ. As. Soc. Bengal*, II, p. 8.

We again quote Mr. Regan's description of the species to facilitate reference.

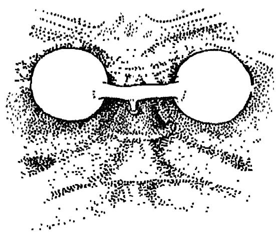
> "Depth of body 7 to 10 in the length, length of head 5 to $5\frac{1}{2}$. Depth of head $\frac{3}{4}$ to $\frac{4}{5}$ its breadth, which is $1\frac{3}{5}$ to $1\frac{2}{3}$ in its length. Diameter of eye $7\frac{1}{2}$–$8\frac{1}{2}$ in the length of the head and $1\frac{1}{2}$ to 2 in the interorbital width. Snout longer than postorbital part of head. Cleft of mouth extending to below the nostrils; lips moderately thick, smooth, the lower interrupted medianly; six barbels; outer rostral barbel as long as the maxillary barbel, extending to or beyond the nostrils. Scales entirely wanting. Dorsal III 7, its origin nearer to tip of snout than to base of caudal; free edge of the fin convex. Anal II-III 5. Pectoral extending about $\frac{1}{2}$ of the distance from its base to the base of the ventral. Ventrals 8-rayed, originating below the anterior branched rays of the dorsal, extending $\frac{1}{2}$—$\frac{3}{5}$ of the distance from their base to the origin of anal. Caudal slightly emarginate. Caudal peduncle 2 to $2\frac{3}{4}$ as long as deep, its length 5 to $5\frac{1}{3}$ in the length of the fish. Large, oblong or rounded dark spots on the back and sides; dorsal and caudal with some small dark spots, lower fin pale, immaculate."

"Three specimens 165–260 mm. in total length."

[1] See Gravely, *Rec. Ind. Mus.* XVIII, p. 137 (1920).

"Perhaps allied to *N. sargadensis*, Nikolski, 1899, the description of which is somewhat deficient in structural details, but the colouration appears to be too different to justify identification."

The largest specimen referred to by Mr. Regan is now in the collection of the Zoological Survey of India and is labelled as the type. Our measurements do not altogether agree with his, for we estimate the length at a little over 268 mm. We find that the head is contained in the total length without the caudal fin $5\frac{1}{2}$ times and the greatest depth of the body nearly 11 times. The difference is evidently due to the fact that the specimen is somewhat curved. We have taken the mean length of the measurement obtained along the outer and that along the inner side.



TEXT-FIG. 15.—Air-bladder of *Adiposia rhadinaea*, × 2.

The bladder has been dissected out of its bony capsule but remains *in situ* pressed against the lower surface of the vertebral column.

We have failed to find any trace of scales. The air-bladder differs from that of *A. macmahoni* in that the posterior diverticulum is extremely short and its vesicle minute.

The fish is readily distinguished from its ally by its more elongate body, smaller, narrower and less flattened head and by marked differences in outline. These differences are shown in our figures of the types of the two species.

All the specimens known were obtained by the Seistan Arbitration Commission in the delta of the Helmand.

Adiposia from Seistan.

Measurements (in millimetres). Number of Fin-rays and Proportions.

		Adiposia macmahoni									*Adiposia rhadinaeus.*
1	Total length (including caudal) ..	76·5	90·6	107·9	113·2	118·5	124·0	129·0	132·2	273·2	268·4
2	Length of caudal ..	14·3	15·2	16 6	17·0	16·5	18·5	19·2	20·6	30·0	37·8
3	Greatest depth of body	7·7	9·5	12·5	15·0	15·0	16·3	15·4	14·4	36·5	21·2
4	Length of head ..	13·6	15·5	18·5	23 0	23·0	25·1	25·0	22·0	57·7	41·8
5	Width of head ..	8·6	9·7	11·7	15·3	15·8	17·3	17·0	13·8	36·5	27·2
6	Length of snout ..	6·0	6·6	8·4	10·3	10·3	11·0	11·0	10·2	4·6	19·5
7	Diameter of eye ..	2·7	2·9	3·3	3·4	3·1	3·6	3·3	3·3	6·7	5·5
8	Interorbital width ..	3·6	4·2	5·2	6·0	6·3	7·0	6·8	5·7	18·0	11·2
9	Longest ray of dorsal.	12·7	14·2	16·4	17·4	17·0	16·0	18·2	19·8	25·2	37·5
10	Longest ray of anal..	10.5	11·0	14·8	13·5	15·2	15·4	14·0	17·0	29·4	30·8
11	Length of pectoral ..	11·4	13·3	14·5	15·0	15·5	15·5	16·0	17·5	26·1	26·7
12	No. of branched-rays in dorsal	7	7	7	7	7	7	7	7	7	7
13	No. of branched-rays in anal.. ..	5	5	5	5	5	5	5	5	5	5
14	$\frac{1}{2}$	*5·35*	*5·95*	*6·5*	*6·65*	*7·18*	*6·7*	*6·71*	*6·41*	*9·1*	*7·1*
15	$\frac{1}{3}$	*9·93*	*9·53*	*8·63*	*7·54*	*7·9*	*7·6*	*8·37*	*9·18*	*7·76*	*12·66*
16	$\frac{1}{4}$	*5·65*	*5·84*	*5·83*	*4·92*	*5·15*	*4·94*	*5·16*	*6·00*	*4·73*	*6·42*
17	$\frac{1}{7}$	*5·03*	*5·36*	*5·6*	*6·76*	*7·41*	*7·0*	*7·57*	*6·66*	*8·37*	*7·6*
18	$\frac{\text{1-Caudal}}{2}$, ..	*4·35*	*4·95*	*5·5*	*5·65*	*6·18*	*5·7*	*5·71*	*5·41*	*8·1*	*6·1*
19	$\frac{\text{1-Caudal}}{3}$, ..	*8·07*	*7·94*	*7·3*	*6·41*	*6·8*	*6·41*	*7·13*	*7·75*	*6·66*	*10·87*
20	$\frac{\text{1-Caudal}}{4}$, ..	*4·57*	*4·86*	*4·93*	*4·18*	*4·43*	*4·2*	*4·39*	*5·07*	*4·21*	*5·51*

APPENDIX.

NOTE ON THE FISHERIES OF THE DELTA OF THE HELMAND AND ON THE USE OF SHAPED RAFTS OF BULRUSHES IN INDIA AND SEISTAN.

By N. ANNANDALE, *D.Sc., F.A.S.B.*

There can be few lakes that bear fish and have a piscivorous population on their shores in which the fisheries are of a more simple character than those of the Hamun-i-Helmand. Apparently only one species the Seistan Trout Carp (*Schizothorax zarudnyi*) is pursued, and only one method of capture used.

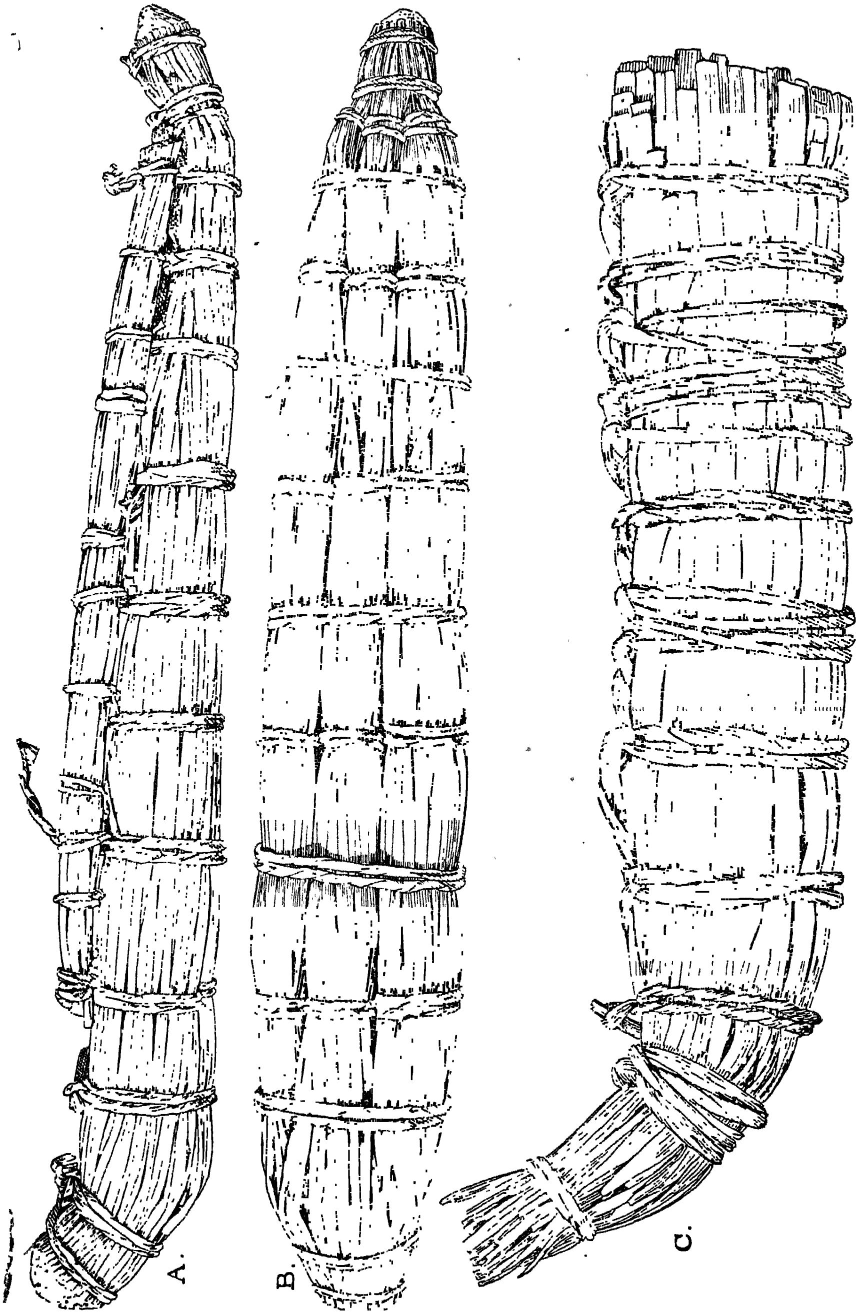
Schizothorax zarudnyi is a fish that bears considerable but quite superficial resemblance to a trout and reaches a length of at least 49 cm. (19 inches). The flesh has an excellent flavour, distinctly "trouty," but is so full of little sharp, stiff bones that it is difficult for a European to eat it. The Persian officials in Seistan get over this difficulty by cooking it in vinegar, which softens the bones; but the fishermen of the Hamun adopt no such refinements. They split and gut the fish and insert a small sharpened stick into the head from below. They then make a small fire of tamarisk-roots and arrange the fish round it in a circle, supported in a slanting position on the sticks. The flesh is thus slowly roasted.

There is some evidence that the flesh of the Seistan Trout Carp, and especially its roe, may be poisonous to those not accustomed to it. We ourselves experienced considerable intestinal disturbance and colic after eating a dish of the roe, and all our assistants and servants except one were taken ill in a similar but more violent manner on another occasion after eating the flesh. In both cases the fish was perfectly fresh. The people of Seistan, however, know of no such inconvenience.

Before describing the method of catching this fish it is necessary to say something about the fishermen and their neighbours on the shores of the Hamun-i-Helmand, and about their peculiar rafts of bulrushes. I take the opportunity also to publish a note on a similar craft used in India.

The shores of the Hamun are inhabited by two different types of people,[1] both more or less nomadic, but occupying different positions in Seistani society. They are called Gaodar (Gavdar) or Herdsmen and Saiyad (Saiad) or Hunters. The Herdsmen are regarded as eminently respectable people, but the Hunters, probably as a result of ancient Buddhist influence, are practically

[1] For a fuller account of these people see Tate, *Seistan*, pt. IV, pp. 297 and 303.



16.—Shaped rafts of bulrushes and sedges from Seistan and India.
Tutin used by fishermen and fowlers on the Hamun-i-Helmand.
Bindi used by fishermen of the Sirkula tribe, Roorkee, U.P.

outcastes. Both tribes pay an annual rent to the Persian government for the right to exercise their respective callings on the shores or in the waters of the lake; the Herdsmen for the pasturage of their cattle, the Hunters for the privilege of fishing and fowling.

One of the most striking features of the Hamun-i-Helmand is the vast reed-beds by which it is surrounded. These vary in extent with the season, but a considerable part of Seistan is known as the *Naizar* or reed-country. The reed-beds provide a livelihood to both the Herdsmen and the Hunters. The reeds are of three kinds. The most abundant is a form of *Phragmites communis*, the common large reed of the fens of England. The dwellings of both tribes are constructed of this plant. Next in abundance is the sedge *Scirpus littoralis*, on which the herdsmen feed their cattle, and finally we have a bulrush (*Typha augustata*), out of which both tribes construct the only craft known on the lake.

No true boats are used in Seistan, but their place is taken by curious "shaped" rafts that may almost be called skiffs and may be compared with the Papyrus skiffs [1] of ancient Egypt and the rafts used in Babylonian times in the delta of the Tigris and Euphrates. These rafts are made entirely of the leaves of the bulrush tied together in bundles. For purposes of transport comparatively stout and clumsy structures [2] of the same kind are employed, but these can only be used in the flood-season and we did not see them. I shall, therefore, describe only those used in fishing and fowling on the Hamun.

These are slender and even elongate structures each made of three bundles of fresh bulrush leaves and about six times as long as broad. Omitting the rail or bulwark along the top, they are about twelve times as long as deep. The bulrush leaves are bent upwards at both ends and the bundles are so arranged that the craft tapers slightly behind. A rail is added on each side above in the form of a thinner bundle of leaves. The rafts are about ten feet long and one and a half feet broad. They are constructed in the following manner (pl. xvii, fig. 2):—

The leaves are cut off close to the roots so as to be as long as possible. All those that are in any way damaged are rejected and the narrow tips are cut and thrown away. Perfect leaves thus treated are then laid out on the shore parallel to one another and arranged in bundles in such a way that there are a few more at one end of the bundle than at the other and that the broader bases of the leaves are all at the same end. Ropes are meanwhile manufactured from other leaves of the same plant, two men or boys doing this by twisting the leaves together in opposite directions by hand. When the thick bundles and ropes are ready each

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[1] For an illustration see King's *History of Babylon*, p. 201, fig. 44 (1915), and for Egyptin references Erman's *Life in Ancient Egypt* (*trans.* Tsiarc p. 470 (1894).

[2] For illustrations see McMahon, *Geor. Journ.*, XXVIII (1906), and Tate, *Seistan.*

bundle is bent upwards at either end and fastened together by five bands of rope. Considerable force is exercised in doing this as the stability of the craft depends largely on the tightness of the bundles. After the rope has been twisted round the leaves two men pull the opposite ends taught, pressing against the bundle with their feet and sitting on the ground. The leaves are left free at two ends of the bundle, but the unbound part is considerably longer at the stouter end (at which the basal part of the leaves is situated) than at the narrower, the stern of the embryo raft. Three bundles are thus formed for the body of the raft. They are then tied together, in the same way as each was made individually, by some nine bands of leaf-rope. Two of these bands are situated near each end, and those at the thick end or prow are tied very tight so that the cut basal ends of the leaves expand somewhat. Finally the rail, a thinner bundle of leaves, is added above at each side for comfort's sake to a passenger, and the whole is finished by a short cross-bundle in front between the two rails.

A craft of this kind has a curious resemblance, when unloaded in the water, to an Egyptian mummy (pl. xvii, fig. 1). It can carry a passenger as well as a boatman, who propels it by punting with a pole of tree-tamarisk, but can be used only in very calm water. It is only on exceptionally still days that the Hunters or the Herdsmen, who also use rafts of the kind in moving about the reed-beds, venture into the open lake upon them. They are temporary structures, depending as they do for their buoyancy entirely on the air enclosed in the air-cells of the leaves, which soon decay. Their life is never longer than two months; in hot weather less. The Seistani name for them is *tutín*, from *tut*, a bulrush.

My figures in the text (figs. 16A & B) are drawn from a model made at Lab-i-Baring on the Hamun. It is accurate except in two points,—(1) the leaves employed are of full size and are therefore relatively larger and less numerous than would be the case in the real raft, and (2) the protuberance at the prow is rather too small (*cf.* the photograph on pl. xvii).

On our return journey from Seistan I happened to show this model to Mr. W. J. Good of the Calcutta Port Trust, who was then a member of the Indian Reserve of Officers. He told me that he had seen similar rafts in the Roorkee district of the United Provinces and kindly put me into communication with Lt.Col. A. Cunningham, R.E., who has supplied me with the following interesting note, with the photograph reproduced in fig. 3 of plate xvii, and with the model from which text-figure 16C has been drawn.

"The floats used for fishing in the *jheels*, of the Solani and Ganges Rivers *kadir* near Roorkee, U.P., about 20 miles to the South East, are about 8′ long by 2′ diameter, and the cross section is circular, flattened at top and bottom a little. They are solid, made of the local *jheel* grasses, the bundle being tied round at several places with rough ties of grass. The prow is formed into

a point and turned up, the model shows this fairly well. They carry one man, or even two at a pinch; the man stands up and the *Bindi* is propelled by a pole of common bamboo, etc., about 10 to 12 feet long. They are crank and difficult for a European to manage. The fishing is with a spear or a circular casting net.

"They are used by the "Sirkulas," a Mahomedan tribe, numbering about 50 families perhaps. They say they came from Sind from the Manchar Lake, about three generations ago (about 1820 probably); my informant says it was in the time of his grandfather, and he himself is an old man of 60 about. They came because there were wars in Sindh. This is corroborated, as they speak Sindhi, and know all the different kinds of duck by the Manchar Lake names, (I have been to the Manchar and know these names myself, having kept a note of them). They do not intermarry with the dwellers in the kadir villages, who are Hindus of the low caste of Chumar: the chumars do not fish, nor do they use Bindis for other purposes. So presumably the "Sirkulas" brought the shape of the Bindi with them from Sindh, however I do not remember seeing any Bindis on the Manchar; perhaps nowadays the wooden dugout of the present-day Manchar fishermen has ousted the Bindi there.

"The *Bindi* is made preferably from the flat dark-green rush called here *Patera* the *Typha latifolia*: this rush floats even when newly cut, and it will last in a Bindi for about six months, before it rots. This rush is fairly strong and stiff when bound up into a Bindi, and the best Bindis are made of it. The round green reed, called *Tukla* locally, the *Cyperus alterifolius*, is also used at times for making Bindis, it also floats when freshly cut, but the disadvantage of it (compared to *Patera*) is that it is not strong nor stiff, like *Patera*, and the Bindi made of it does not last so long, and will not bear so much handling. The Latin names have been got from the Superintendent, Government Botanic Gardens, Saharanpur, to whom specimens of the grasses were sent.

"The *Patera* grows in water, to about 12 feet high, while the *Tukla* only runs to about 5 feet at most, it also grows in water.

"One of the characteristic points of the shape of the Bindi is the way the prow, or front end, is brought to a point and sticks up about a foot or so above the level of the top surface of the body of the Bindi. The grass in the Bindi is tied round at intervals with wisps of the same grass made into a rough sort of rope."

In many parts of the Madras Presidency rough bundles of reeds are used as rafts by fishermen, especially in the large tanks and reservoirs that are a feature of southern India; but these bundles are not shaped and I have heard of no instance of shaped rafts being employed in Perninsular India. The fact that the people who use them in the United Provinces are of Sindi origin is interesting as suggesting an actual historic connection between their manufacture in those provinces and in Seistan, for Sind is in many respects a country intermediate between India and Persia. As to the possible but more remote connection with Babylonia and

Egypt, I have not the learning necessary for a discussion on the subject The *bindi* (fig. 16C) is of simpler construction than the *tutin*, but may be degenerate.

Except their bulrush rafts and punting poles the only implement used in fishing by the fishermen of the Hamun is a cotton net of simple structure. The cotton is grown locally. The net is oblong in shape, about 4 feet deep and 100 feet or more in length. The mesh is very large, allowing all small fish to escape.

In setting the net it is tied above and below at each end to a pointed tamarisk stick. The pointed end of these sticks is struck into the bottom of the lake and they are arranged in such a way in reference to the direction of the wind, and therefore of currents in the water, that the net forms a semicircle with its lower edge on the bottom and its upper edge slightly above the surface. It is set in a position into which it is easy to drive the fish, often in an open channel in the reed-beds or, in exceptionally calm weather, just outside one in the open lake. In the former case the channel is usually one that leads out of an open pool and suitable pools are apparently kept free of reeds for the purpose.

A considerable number of fishermen, each on his *tutin*, take part in driving the fish into the net. They arrange their rafts in a wide semicircle opposite that of the net and gradually converge towards it, beating the water with their poles and ululating with the peculiar sound conventionally transliterated "halelujah" in English religious works. They show great skill in directing a few vigorous downward strokes with their poles to give the rafts an impetus, and then striking the water before the forward movement ceases. The fish are gregarious and apparently rather sluggish and are easily frightened into the net in this manner.

When the semicircle of rafts has completely converged on that of the net the supporting sticks are pulled out of the water simultaneously by the men in the two end *tutins*, and turned up horizontally in such a way that the net is transformed into a bag. The two ends are then drawn at the same time into the two *tutins*, which approach one another as rapidly as possible.

Unlike Indian fishermen the Saiyad despise all small fish and do not attempt to catch any much less than a foot in length.

We saw a similar method of fishing used in small channels leading out of the Hamun. Here the net was much shorter and was stretched right across the channel. The men who used it waded in the water.

The only other method of fishing that we saw in Seistan was employed in pools in the dry stream-bed of Randa near the ruined city of Jellalabad. Here a rude and particularly clumsy kind of trawl was used. The net was a large bag, with considerably smaller meshes than that employed in the Hamun. It was fastened to one horizontal and two upright poles. The horizontal pole lay on the bottom of the pool and the two upright ones were held in position by means of ropes attached to their upper ends. Four men worked this trawl, two pulling ropes attached to the

ends of the horizontal pole and two other ropes fixed to the upper end of the upright ones. The four men waded along in the water. The awkwardness of the apparatus lay in the fact that unless all of the men moved together the upper ends of the two poles fell towards one another and the net refused to work properly.

We were told that around Nasratabad the favourite method of fishing was for men to go out into the swamps in the flood-season with swords and to strike at any fish they saw. Our informant, who had had great experience of the country, said that quite large fish were killed in this way.

In the Helmand River in the east of Seistan a more elaborate method of fishing is apparently practised. The following notes are taken from an official document. The author of part of these notes believes that the fish captured belongs to the genus *Schizothorax*. There is a single specimen of *S. zarudnyi* in the collection of the Seistan Arbitration Commison from the Helmand, but the largest fish caught by the author of the note weighed 12 lb., which is much heavier than any fish seen in the Hamun-i-Helmand. *Schizothorax* would seem to be the only genus of fish captured for food in Seistan.

"SEISTANI FISHING NET.

"The net used is a bag about 7·0′ long 9″ diameter at the lower end and 6′×2′ wide at the mouth. The net is held open by a pair of poles or prongs tied together at one end to make a fork. The fork pivots on a post on the bank. The fisherman sits on a platform. Across the mouth of the net fine lines are arranged, the lead string of which the fisherman holds in his hand to get timely warning that a fish has entered the net, whereupon he pulls the net up and removes the fish. The fork that holds the net is held in position by the strain of guy ropes. The net is placed on the bank near a pool at a place where there is a swirl or back water so as to intercept the fish moving along the edge of the bank; sometimes it is put up across the mouth of a small canal; a shallow channel is sometimes obstructed by a line of stakes along which the fish move till they come to the opening where the net is arranged and are caught. Below the Band-i-Seistan the net is arranged opposite a small leak in the *Band* and fish moving along the down stream face of the *band* are swept into the net by the force of the current at this place.

The favourite spots for the big fish are in the slack back water close to where the backwater meets the force of the down-flowing current. At such places the small fry, which at certain seasons work their way up the river in thousands swimming as close to the bank as possible, are checked by the current and fall an easy prey to the larger fish which feed on them ravenously.

The autumn is the best season for fishing operations of this nature. The season of 1903 commenced as early as August and continued for several weeks. In 1904 it was late in September

before fish moved and not really well till October. March and April are also sometimes favourable if the river is not very full, but the fish do not move so freely then as in the autumn. During the hot weather (May-August) the fish are quite out of condition.

'LIST OF TECHNICAL TERMS CONNECTED WITH THIS METHOD OF FISHING:—

Name in Roman Characters.	*Explanation of the meaning and use of the word.*
[1] Bok ..	Platform on which the fisherman sits.
Ruka ..	Each pole or prong of the frame of two tamarisk poles fitted together to form a fork which holds the net.
Shingalak	The strut which separates the two poles or prongs of the fork.
Achchá	A forked pole, here used as supports to the platform.
Ásak	The piece of wood which acts as a trunion or pivot on which the fork of the frame revolves.
Dahan-i-ruká	The taut rope which holds together the ends of the poles of the fork.
Dast kash .	The rope by which the frame and net are raised or lowered, and by which it is maintained in its position in the water.
Pish-áb .	The rope that stays the frame against the whirl of the water, as the net is usually set up where there is a swirl in the water.
Sarkash ..	A stay that is used when there is a strong wind.
Maraká ..	The string which passes to the finger of the fisherman, and to which are connected the lines which are spaced across the mouth of the net. The fish touches these lines and warns the fisherman of its advent, whereupon he lifts the net out of the water.
Gi	The line which holds the upper side of the net, and is made fast to a stake on the bank. The lower side of the net is made fast to the lower pole.
ushtak	A ring in the rope on the *dahani-rúká* where the *maraká* and *pásáo* are made fast.
	The pocket of the net.

[1] The Baluchis use the same words in describing the parts of this fishing net except that for *k* they say *Barmak* and for *Kisa* they say *Kito*.

Gislak ..	The line on which the fish that are caught are strung by the gills and kept in the water.
Shak ..	The handle of wood at the other end of the *gislak* for attaching it to a stake on the bank; it also acts as a needle to pass the line through the gills of the fish.
Dám ..	Is the net.
Dám-i-boki ..	This whole arrangement for catching fish.
Charkháb ..	Swirling back water forming a suitable place to set up this arrangement to catch fish.
Máhígír ..	Fisherman.
Máhí ..	Fish."

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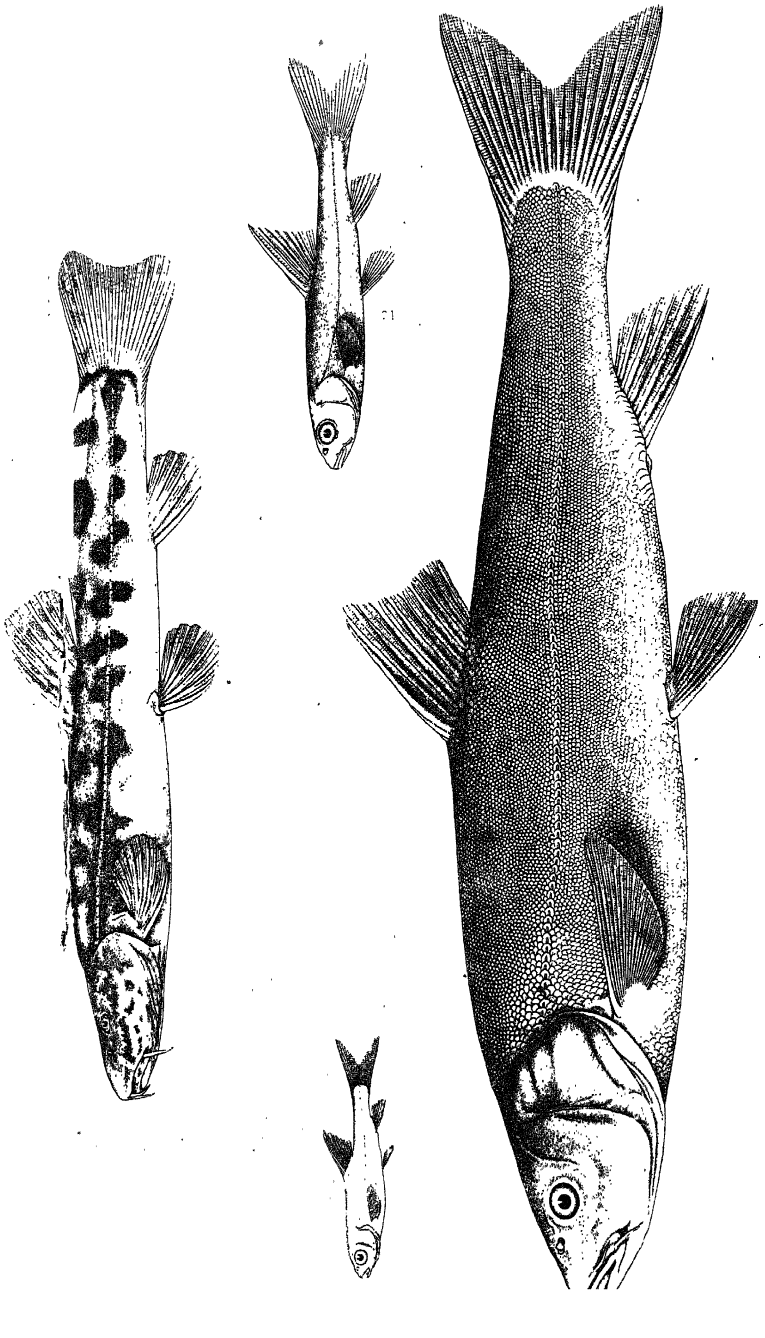


EXPLANATION OF PLATE XVI.

Soft fin of **Adiposia**, etc.

FIG. 1.—Vertical section of soft fin of *Adiposia macmahoni*, stained with haematoxylin, × 60.

„ 2.—Part of the lateral region of the same preparation, × 200.

„ 3.—Vertical section of the dorsal fold (behind the dorsal fin) of a post-larval *Nemachilus evezardi* 1 cm. long, stained with haematoxylin, × 200.

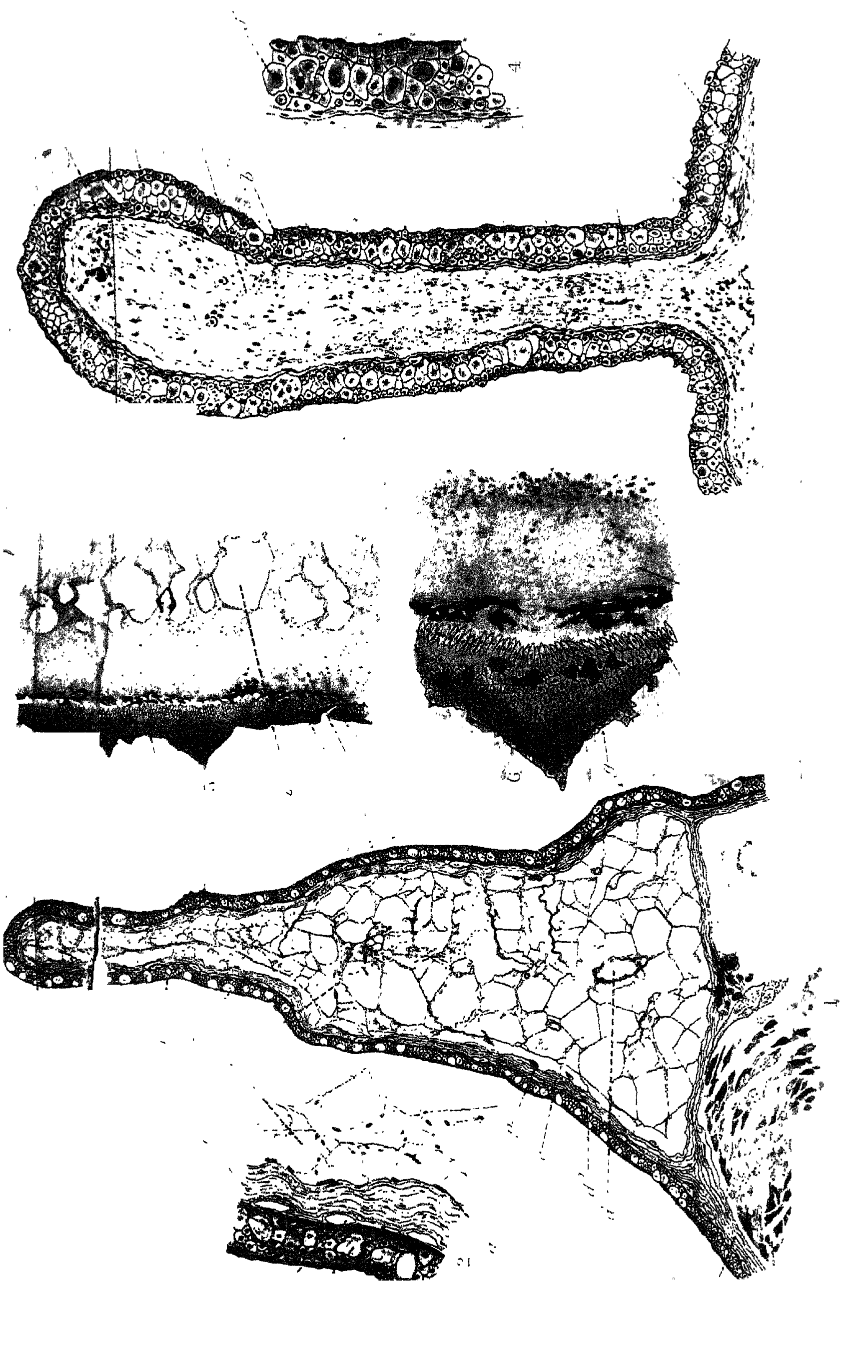
„ 4.—Part of the lateral region of the same preparation, × 300.

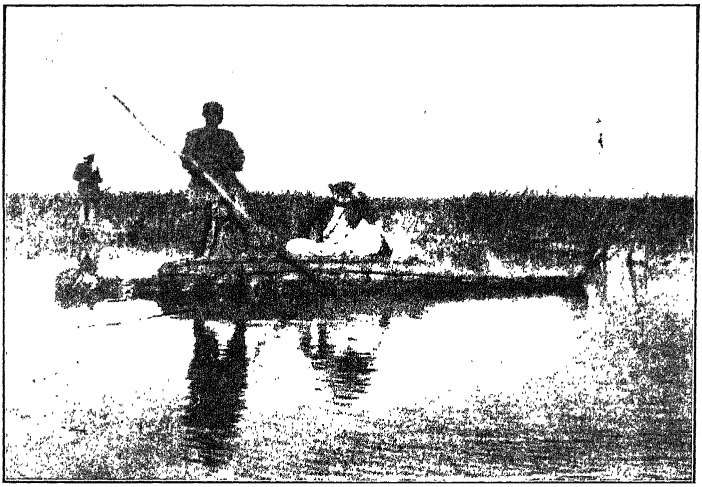
„ 5.—Part of the lateral region of a vertical section of the soft fin of *Glyptosternun* sp. (fam. Sisoridae, suborder Siluroidea), stained with haematoxylin, × 80.

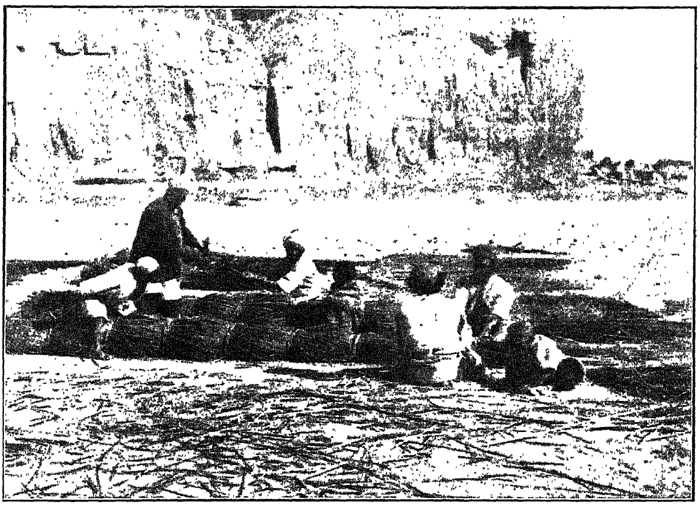
„ 6.—Part of the same preparation, × 200.

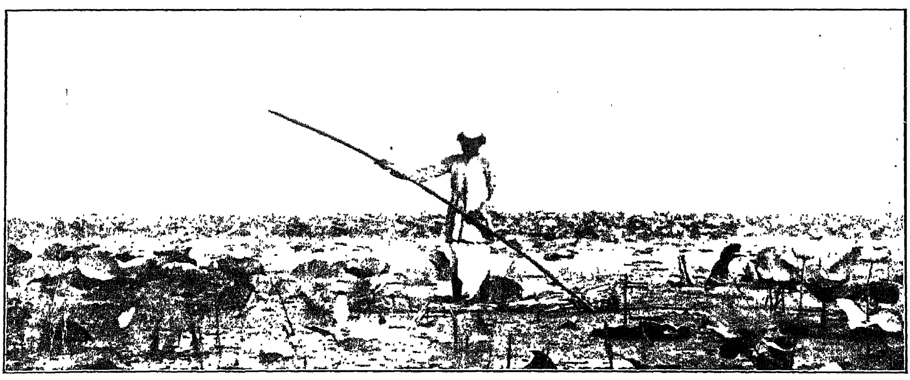
EXPLANATION OF LETTERING.

a=vacuolated tissue. *b*=epithelial region. *c*=fibrous connective tissue. *d*=large blood-vessel. *d'*=small blood-vessel. *e*=dorsal muscles. *f*=gland-cell. *g*=pigment-masses. *g'*=dendritic pigment-cell. *h*=unstriped muscle cells.









SHAPED RAFTS IN INDIA AND SEISTAN.

III. NOTES ON FISHES IN THE INDIAN MUSEUM.

I. On a New Genus of Fish closely resembling *Psilorhynchus*, McClelland.

By Sunder Lal Hora, *M.Sc., Research Assistant, Zoological Survey of India.*

While sorting out the fish of the genus *Garra* in the unnamed collection of the Indian Museum, I happened to mistake the specimen described below for one of *Garra*. On closer examination it has turned out to be an interesting species of a new genus, which I propose to describe in this paper.

Parapsilorhynchus, gen. nov.

The new genus consists of small hill-stream Cyprininae closely resembling *Psilorhynchus*, McClell., from which it differs in the following characters:—

(i) There are two blunt, cylindrical barbels on the snout in the new genus, while in *Psilorhynchus* barbels are absent.

(ii) In *Psilorhynchus* the air-bladder [1] is always more or less reduced, while in this genus it is large and is of the normal Cyprinid type.

(iii) In *Psilorhynchus* the upper lip is exposed, and the lower lip, though it may be glandular, is never prominent, while in *Parapsilorhynchus* the upper lip is concealed by a fringed, plicate, labial fold which is densely covered with minute tubercles; the lower lip is very prominent, and usually there is either an indication of or a rudimentary disc behind it.

(iv) In *Parapsilorhynchus* the origin of the dorsal is almost opposite to that of the ventrals, while in *Psilorhynchus* it is in advance of the ventrals.

Of this genus I regard *Psilorhynchus tentaculatus*, Annand.,[2] as the type-species. I assign to it also the new species described below. While dealing with the genus *Psilorhynchus* in a recent paper, I provisionally included Dr. Annandale's species in it, but the discovery of the second species in the same range of mountains makes it desirable to lay stress on the differences between the forms found in the north-east of India, and those inhabiting the hills in the western part of Peninsular India. Dr. Annandale tells

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[1] Hora, *Rec. Ind. Mus.* XIX, p. 209 (1920).

[2] Annandale, *Rec. Ind. Mus.* XVI, pp. 128-129 (1919).

me that he considers these forms to be probably convergent; but in describing *Psilorhynchus tentaculatus* preferred not to set up a new genus on a monotypic basis.

My new genus has some points in common with *Garra*; the main characters that distinguish it from this genus are the following:—

(i) The presence of two characteristic blunt barbels in a position quite different from that in any species of *Garra* with two barbels.

(ii) The gill-openings extend to the ventral surface, whereas in *Garra* they are usually restricted to the sides.

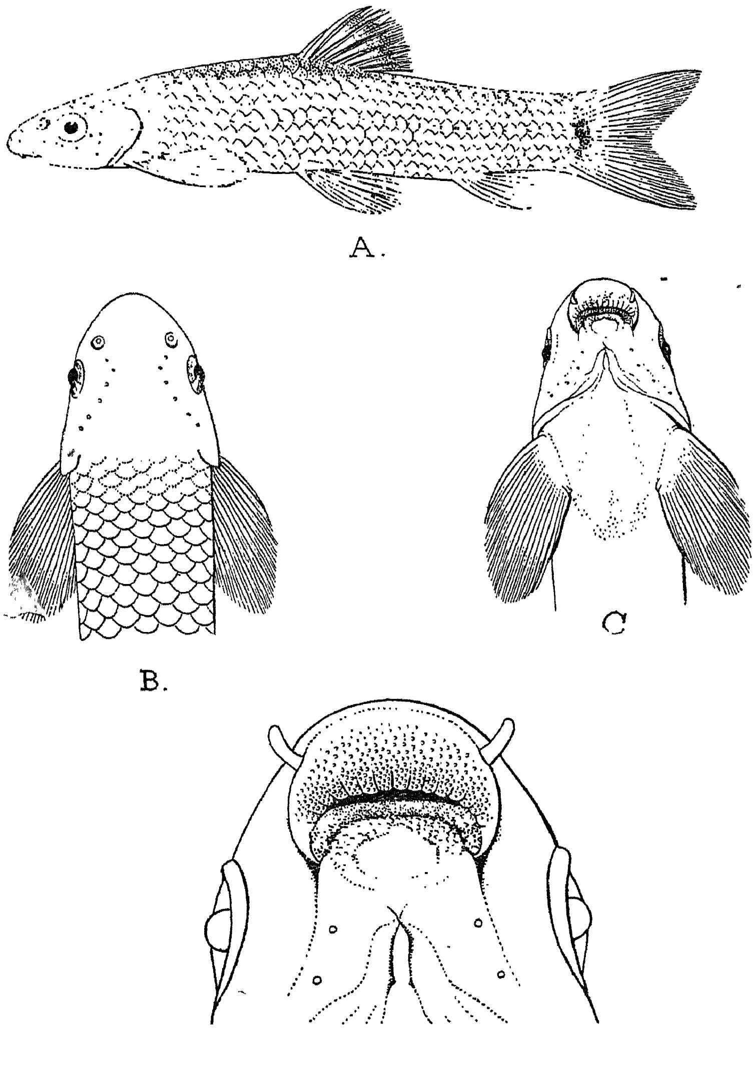
(iii) In *Parapsilorhynchus* the mouth is very small, while in *Garra* it is usually much wider.

Parapsilorhynchus discophorus, sp. nov.

D. 2/6. V. 7. A. 7. P. 16.

This is a small-sized fish, with the back moderately elevated. The dorsal profile rises gracefully from the tip of the snout to the origin of the dorsal, beyond which it slopes imperceptibly down to the base of the caudal fin. The ventral surface is somewhat flattened and its profile is almost straight and horizontal. The length of the head is contained $4\frac{1}{8}$ times, the depth of the body near the origin of the dorsal fin $4\frac{1}{8}$ times, and the length of the caudal fin $3\frac{1}{5}$ times in the total length without the caudal fin. The eyes are of a moderate size and are situated slightly nearer to the posterior margin of the operculum than to the end of the snout; their diameter is contained $3\frac{3}{5}$ times in the length of the head, twice in the interorbital width and $1\frac{1}{2}$ times in the length of the snout. The gape of the mouth is $1\frac{1}{3}$ times the diameter of the eye. The head is short and narrow; its greatest width is contained $1\frac{1}{4}$ times in its length. There are definite rows of open pores on the sides and upper surface of the head and also along the opercular borders on the under surface. The greatest height of the caudal peduncle is equal to its length. The vent is situated in the beginning of the last fourth of the distance between the end of the snout and the base of the caudal fin. There is a pair of short barbels on the snout. The barbels are thick and stumpy and are not pointed distally; they are situated ventrally, a short distance behind the anterior end of the snout and are partly visible from above. There is a deep groove on either side running from the base of the barbel to the angle of the mouth. The mouth is small and crescentic, and is situated on the ventral surface considerably behind the anterior end of the snout. The upper labial fold is long and fringed and is covered with minute tubercles. The lower lip forms the anterior free border of the mental disc and is studded with fairly big tubercles. The labial fold tapers towards the angle of the mouth and partially covers the lateral borders of the lower lip. The most significant point about this species is the presence of a small, rudimentary disc behind the lower lip. The

disc consists of an oval callous portion in the middle, with its longest diameter at right angles to the length of the fish and a well-



Parapsilorhynchus discophorus, sp. nov.

A. Lateral view of the type-specimen, × 2.
B. Dorsal surface of head of the same, × 3.
C. Ventral surface of head of the same, × 3.
D. Anterior part of the ventral surface of head of the same, × 9.

defined tubercular border anteriorly, but becoming obscure behind. The opercular borders meet a short distance behind the mental

disc. The scales are small and are totally absent from the ventral surface; there are 34 scales along the lateral line and 9 rows between the bases of the dorsal and the ventral fins. The dorsal fin is $\frac{3}{4}$ as high as the depth of the body below it; it is situated nearer to the base of the caudal than to the end of the snout and its origin is equidistant from the nostrils and the base of the caudal. The origin of the ventrals is almost opposite or slightly behind that of the dorsal fin. The pectorals are shorter than the head and are separated from the ventrals by a considerable distance. The caudal is forked and both the lobes are pointed. The ventrals are provided with a short fleshy appendage. The air-bladder is of the normal Cyprinid type.

The sides and the upper surface of the head are dusky; while the ventral surface is white. There is a dark bar across the dorsal fin near its free border and a short black bar at the base of the caudal.

Type-specimen.—F. 9952/1. *Zool. Survey of India* (Ind. Mus.).

Locality.—Only one specimen was obtained by Dr. F. H. Gravely at Pophli in the Vashishti valley, in the Western Ghats, Ratnagiri district, Bombay Presidency, at an altitude of 400 ft.

Measurements in millimetres.

Total length excluding caudal ..	33·0
Depth of body in front of dorsal	8·0
Length of head	8·0
Width of head	6·5
Diameter of eye ..	2·2
Length of snout	3·3
Interorbital width	4·5
Gape of mouth	3·0
Length of caudal peduncle ..	5·5
Least height of caudal peduncle	5·0
Height of dorsal fin	6·5
Length of pectoral	7·5
Length of ventral	6·5
Length of anal ..	5·0
Length of caudal	8·5
Distance of vent from end of snout	24·0

The new species is closely related to *Parapsilorhynchus tentaculatus* (Annand.), recently described from the adjacent Poona and Satara districts of the Bombay Presidency. The fundamental points of resemblance are the presence of two short, stumpy and blunt barbels on the snout and also the presence of a well-defined air-bladder. The species are also alike in having a narrow and pointed operculum which is sharply marked off and bluntly truncate above. In both the species there is a black bar across the dorsal and a black spot at the base of the caudal fin. The

general facies in the two is similar as is also the position of the mouth and the structure of the labial fold. The points of differences are, however, numerous and important. In a well-preserved specimen of *P. tentaculatus* a small pad can be made out just behind the bilobed lower lip, while in the new species there is a distinct callous disc and the lower lip is not bilobed. In *P. discophorus* the ventral surface is more rounded and is absolutely devoid of scales, the head is shorter and narrower and the eyes are distinctly visible from below. The two species also differ in proportions and number of scales. The paired fins in *P. discophorus* are not so expanded as in *P. tentaculatus* and are not provided with muscles on their ventral aspect.

XIX. FISH AND FISHERIES OF MANIPUR WITH SOME OBSERVATIONS ON THOSE OF THE NAGA HILLS.

By SUNDER LAL HORA, *M.Sc., Officiating Assistant Superintendent, Zoological Survey of India.*

(Plates IX—XII.)

CONTENTS.

The collection dealt with in this paper was made by the Zoological Survey Party which visited Manipur in February and March, 1920, and also to a large extent by myself. My best thanks are due to Sardar Dogar Singh, the State Overseer at the time of our visit, who after the departure of Dr. Annandale and other members of the party gave me material assistance in the collection of specimens and in arrangements for touring. He accompanied me to most of the places in the valley and helped me in various other ways. I am also indebted to Mr. A. C. Eleazar for giving me photographic prints from his valuable collection of negatives. Some of these are reproduced here as illustrations. To the Political Agent, Mr. C. W. R. Cosgrave, I am indebted for the services of a man who gave me great assistance in collecting.

My sincere thanks are due to Drs. Annandale and Kemp, to

the former for the great help and valuable suggestions that he gave to me throughout the preparation of this paper, and to the latter for going through the manuscript with me. Dr. Annandale's Monograph[1] on the Fish and Fisheries of the Inlé Lake has served me as a model in writing up the results of my investigations. The illustrations were executed under my supervision by the artists of the Zoological Survey with their usual skill and I must express my indebtedness to them for this work.

INTRODUCTION.

Only a few species of fish have hitherto been recorded from the Manipur Valley and the hills in its immediate vicinity. Day, in his volumes in the *Fauna of British India* records only three from the Naga Hills, *Erethistes hara*, *E. elongata* and *Danio acquipinnatus*. Specimens of other species have, however, been collected in small numbers from time to time in the streams of these mountains. Over half a century ago a small collection was made by Col. H. H. Godwin-Austen, but so far as my knowledge goes no account of it has been published. More recently, in 1910, the Rev. Mr. Pettigrew sent to the Indian Museum a small collection of fish from the hill streams of Northern Manipur. The species in this collection, as Dr. Annandale informs me, were all obtained in the hill country, probably from the neighbourhood of Ukhrul which is situated at an altitude of 6,000 ft. Two new species found by Mr. Pettigrew, *Nemachilus manipurensis* and *Danio naganensis*, were described by Dr. B. L. Chaudhuri,[2] while notes on some of the other species are incorporated here.

The list of the species given below is based on the information obtained from all these sources and from our own collection, which is of course much the largest. Under the name Naga Hills I include all the country inhabited by Naga tribes and not merely the district to which the name is officially applied.

LIST OF FISHES OBTAINED FROM MANIPUR AND THE NAGA HILLS.

LOKTAK LAKE.

Clarias batrachus (Linn.).
Callichrous bimaculatus, Bloch.
Macrones bleekeri, Day.
Labeo calbasu (Ham. Buch.).
Labeo pangusia (Ham. Buch.).
Barbus sarana caudimarginatus, Blyth.
Rohtee belangeri (C. and V.).
Lepidocephalichthys irrorata, sp. n.
Ambassis ranga (Ham. Buch.).
Ophiocephalus harcourt-butleri, Annand.
Barbus conchonius (Ham. Buch.).
Barbus ticto (Ham. Buch.).

[1] Annandale, *Rec. Ind. Mus.*, XIV, pp. 33—64, pls. i—viii (1918).

[2] Chaudhuri, *Rec. Ind. Mus.*, VII, p. 443, pl. xl, figs. 4, 4*a*, 4*b* and pl. xli, figs. 1, 1*a*, 1*b*; p. 441, pl. xl, figs. 1, 1*a*, 1*b* (1912).

SLUGGISH STREAMS IN THE MANIPUR VALLEY.

Clarias batrachus (Linn.).
Wallago attu (Schn.).
Callichrous bimaculatus, Bloch.
Marcrones bleekeri, Day.
Macrones (*Macronoides*) *affinis* (Blyth).
Glyptothorax[1] *dorsalis*, Vinciguerra.
Glyptothorax minutus, sp. n.
Gagata cenia (Ham. Buch.).
Garra nasutus (McClelland).
Labeo calbasu (Ham. Buch.).
Labeo angra (Ham. Buch.).
Labeo pangusia (Ham. Buch.).
Crossochilus latia (Ham. Buch).
Barbus ticto (Ham. Buch.)
Barbus conchonius (Ham. Buch.).
Barbus sarana caudimarginatus, Blyth.
Rohtee belangeri (C. and V.).
Rohtee alfrediana (C and V.).
Barilius barila (Ham. Buch.).
Danio (*Brachydanio*) *acuticephala*, sp. n.
Botia berdmorei (Blyth).
Botia histrionica, Blyth.
Lepidocephalichthys berdmorei (Blyth).
Lepidocephalichthys irrorata, sp. n.
Acanthophthalmus pangia (Ham. Buch.).
Nemachilus zonalternans (Blyth).
Ambassis ranga (Ham. Buch.).
Mastacembelus manipurensis, sp. n.
Ophiocephalus harcourt-butleri, Annand.

STREAMS WITH ROCKY BED IN THE SOUTHERN WATERSHED OF THE NAGA HILLS.

Garra rupiculus (McClelland).
Garra abhoyai, sp. n.
Crossochilus latia (Ham. Buch.).
Barbus hexastichus, McClelland.
Barbus conchonius (Ham. Buch).
Barbus oatesii, Boulenger.
Barilius barila (Ham. Buch.).
Barilius dogarsinghi, sp. n.
Danio æquipinnatus (McClelland).
Danio naganensis, Chaudhuri.
Danio (*Brachydanio*) *acuticephala*, sp. n.
Lepidocephalichthys berdmorei (Blyth).
Acanthophthalmus pangia (Ham. Buch.).
Nemachilus manipurensis, Chaudhuri.
Nemachilus zonalternans (Blyth).
Nemachilus sikmaiensis, sp. n.
Nemachilus kangjupkhulensis, sp. n.
Nemachilus prashadi, sp. n.

STREAMS WITH ROCKY BEDS IN THE NORTHERN WATERSHED OF THE NAGA HILLS.

Erethistes hara (Ham. Buch.)
Erethistes elongata, Day.
Psilorhynchus, sp., Hora.
Garra naganensis, sp. n.
Barbus clavatus, McClelland.
Barbus tor (Ham. Buch.).
Barilius barila (Ham. Buch.).
Danio dangila (Ham. Buch.).
Danio aequipinnatus (McClelland).
Lepidocephalichthys guntea (Ham. Buch.).

[1] In a paper to be published shortly I give reasons for adopting this name in preference to *Glyptosternum*.

Barbus hexastichus, McClelland.
Rasbora rasbora (Ham. Buch.).
Barilius bendelisis var. *chedra* (Ham. Buch.).
Nemachilus botia (Ham. Buch.).
Badis badis (Ham. Buch.).
Rhynchobdella dhanashorii, sp. n.
Ophiocephalus punctatus, Bloch.

I will now discuss separately the fishes of the four areas enumerated above.

The fish-fauna of the Loktak Lake is, unlike that of the Inlé Lake, [1] not at all specialized. Of the dozen species obtained from it none are endemic, and all these have also been found in the streams of the valley. The only new species from the lake is a small loach of the genus *Lepidocephalichthys* which was equally abundant all over the valley. The major part of our collection was made in the sluggish streams of the flat country. Here four new species were discovered, one of the genus *Lepidocephalichthys* also found in the Loktak Lake, and others belonging to the genera *Mastacembelus*, *Danio* and *Glyptothorax*. Except the *Mastacembelus*, which may grow to a foot or more in length, the new forms are all very small and apt to be overlooked while collecting. Of the remaining species *Barbus phutunio* is said to have been introduced in the Residency ponds from outside the valley. We obtained a large series of specimens but only from these ponds. The eel (*Monopterus albus*) was found buried in mud at the edge of the lake and in rice-fields and was not obtained from any of the streams.

Most of the new species I collected are from the hill streams of the southern watershed which flow into the Manipur Valley from the adjacent Naga Hills. Their restricted distribution is not surprising since they are only found in localised areas in these streams. The new forms chiefly belong to two genera, *Nemachilus* and *Barilius*.

Of the species listed under the heading "Northern watershed, Naga Hills," *Ophiocephalus punctatus*, *Rasbora rasbora*, *Badis badis* and *Rhynchobdella dhanashorii* were netted by me at Dimapur in the plains just north of the Naga Hills. The discovery of a species of *Rhynchobdella* so far inland is interesting. A parallel instance may be given of a marine genus *Moringua*, which has been recorded from the Abor country by Dr. B. L. Chaudhuri.[2] Most of the species obtained in the Naga Hills were collected in the Mithapani and Senapati Streams near Kairong on the main northern watershed of the range. The rest were captured in small streams at various points on the road between the Manipur Valley and Dimapur.

As a result of our investigations 56 species are now known to inhabit the Manipur Valley and the Naga Hills. Of these 27 belong to the family Cyprinidae, 12 to the Cobitidae and 10 to the Siluridae. The remaining seven species are distributed among the families Symbranchidae, Mastacembelidae, Ophiocephalidae,

[1] *Rec. Ind. Mus.*, XIV, pp. 33—64 (1918).
[2] Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 255 (1913).

Nandidae and Percidae. The large number of species and individuals of the first three families, and especially of the family Cyprinidae is a noteworthy feature of the fish-fauna of these regions. Moreover, the members of these families that live in hill streams show certain adaptive characters which are dealt with in detail under a separate heading.

THE PHYSICAL AND OTHER CONDITIONS AS THEY AFFECT THE FISH.

In the general introduction to the fauna of the Manipur Valley, Dr. N. Annandale has given an account of the Loktak Lake. I need here only mention a few of the features that seem to have a special bearing on the fish-fauna.

Dr. Annandale has referred to the luxuriance of vegetation in the lake and has pointed out that it is blocked up to the surface by a thick growth of *Potamogeton*, *Hydrilla* and *Trapa*. From the fact that no specimen of fish, more than a few inches in length, was found in the lake, it is evident that this thick vegetation, while providing food and shelter for the fish, is inimical to the existence of big species, probably because it would retard their progress and make them an easy prey to water-birds, otters, etc. Cover plays a great part in the life of fish and the readiness with which they seek it in the lake is fully illustrated by the devices employed by the Manipuris in capturing them.

Except the snake-headed fish (*Ophiocephalus harcourt-butleri*) and three species of Siluridae, all the fish generally feed on aquatic weeds, on small worms or insect larvae in the mud. Surface-feeding fish (*Nga-wa*) though abundant in the streams of the valley are totally absent from the lake.

The destruction of fish brought about by man's agency is enormous and in fishing Manipuris do not spare the small forms, which only inhabit the lake. After man the most active agents of destruction are certain species of birds. The stomachs of a few cormorants shot near Potsengbaum were found to be full of specimens of *Lepidocephalichthys berdmorei* and *Monopterus albus*. Large numbers of these birds were often observed sitting on floating islands and feeding on the fishes in the lake. The ducks and geese for which this lake is famous among sportsmen do not appear to do much harm, judging from the contents of their stomachs, unless it be by destroying spawn.

On dissection several species of fish were found to be infected with round worms, but the degree of parasitisation was not very high.

The fish of the sluggish streams in the Manipur Valley comprise all those that live in the lake and include some of those the proper habitat of which is the mountain torrents. It is not surprising to find species of *Glyptothorax*, *Garra*, *Nemachilus* and other highly specialized genera in muddy streams when it is realised that within a short distance a mountain torrent may become a

sluggish stream in almost level country. During my tour I was able to make collections from the same stream at different places where the bed was sometimes rocky and sometimes muddy. For example I made a collection in the Thaubal stream near Yaributk where it is muddy and sluggish and in the same stream about 1 mile from Phadai, where it flows rapidly over a rocky bed. Similarly in Sikmai Stream I made collections at two different places, one near Vabgai in the valley and the other near Palel some six miles from Kakching village, where the stream may be called a torrent. A comparison between the species obtained from the latter stream in the two places is instructive.

Muddy and sluggish, near Vabgai.	Flowing rapidly over a rocky bed, near Palel.
Acanthophthalmus pangia.	*Acanthophthalmus pangia.*
Crossochilus latia.	*Crossochilus latia.*
Macrones bleekeri.	*Garra rupiculus.*
Lepidocephalichthys berdmorei.	*Barilius barila.*
Lepidocephalichthys irrorata.	*Nemachilus zonalternans.*
	Nemachilus sikmaiensis.
	Nemachilus prashadi.

It will be observed that examples of *Garra* and *Nemachilus*, the only genera that exhibit adaptations to life in hill-streams, are found at Palel where the water flows rapidly over a rocky bottom, while those of *Lepidocephalichthys* and *Macrones* that prefer a muddy bottom are only found near Vabgai where the stream is sluggish and muddy. The remaining two species, belonging to *Acanthophthalmus* and *Crossochilus*, are capable of existence under both conditions.

The greatest specialization is found, however, among those fish that actually live in rapid waters. In the species of the genus *Barilius*, the paired fins are greatly expanded and some of their outer rays have become very strong. In older specimens definite muscle-pads are developed on either side of the chest in front of the bases of the pectoral fins. In loaches the mouth is specialized to form a sucker, and by the help of its thick lips the fish are enabled to stick to stones and withstand rapid currents. In *N. sikmaiensis* the mouth is not specialized, but this is compensated for by the higher specialization of the paired fins which are greatly expanded and are provided with muscles on their ventral aspect. The disc of *Garra* and the chest-muscles of *Glyptothorax* are examples of extreme modifications due to adaptation to a particular environment.

GEOGRAPHICAL RELATIONS.

The fish dealt with in this paper belong to two watersheds. The line separating these is a ridge some three miles from Kairong,

between it and Kanglatombi among the Naga Hills. The Imphal River, the chief river of the valley, rises near Kanglatombi and flowing southwards through the valley ultimately joins the Chindwin, a tributary of the Irrawadi. The streams of the northern watershed on the other hand form part of the Brahmaputra System.

Seventeen species of fish belonging to six families and 12 genera are represented from the northern watershed. All the families are widely distributed in the waters of the Oriental and Ethiopian Regions.

Of the 12 genera, 11 are distributed in the freshwaters of the adjacent country, while the genus *Rhynchobdella*, which has hitherto only been found in the deltas of all the large rivers of India and Burma, is now for the first time recorded from far inland.

Of the 17 species, 4 are only known from the Naga Hills. Of the rest, 9 are distributed all over India and Burma and the remaining 4 do not extend to Burma but occur along the base of the Himalayas. *Barbus clavatus*, which is redescribed in this paper, has so far been known from a single specimen obtained from a river at the base of the Sikkim mountains.

On the whole the fauna of the northern watershed, so far as the fish are concerned, is chiefly Assamese and only differs from that of the Brahmaputra Valley in so far as it contains hill-stream species.

Forty-two species of fish collected from the southern watershed belong to six families and 21 genera. All the families are widely distributed in the Oriental and Ethiopean Regions. Of the 21 genera, 20 are widely distributed in India and Burma, while the genus *Monopterus* is confined to south-eastern Asia and has not so far been recorded from the Assam Valley. Of the 42 species, 18 are widely distributed in India and Burma; 11 are known only from Manipur; the remainder with the exception of 3 are exclusively Burmese. Of these 7 were recorded and described from the Sitang River by Blyth,[1] two have been described from the S. Shan States (one by Boulenger[2] and the other by Annandale[3]), and the remaining species by Vinciguerra[4] from Meetan. The only Assamese species are *Garra rupiculus*, which was described from the Mishmi Hills north-east of the Brahmaputra Valley, and *Garra nasutus* of the Khasi and the Mishmi Hills. Annandale,[5] while dealing with the Batrachians of the Abor country, adduced evidence to show that the fauna of the Khasi, Mishmi and other adjacent hill tracts is similar and differs from that found on the other side of the Brahmaputra River. My results confirm the above statement.

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1 Blyth, *Journ. As. Soc. Bengal*, XXIX, pp. 138—174 (1860)

2 Boulenger, *Ann. Mag. Nat. Hist.*, (6) XII, p. 201 (1893).

3 Annandale, *Rec. Ind. Mus.*, XIV, p. 54, text-fig. 2, pl. 2, fig. 7; pl. iv, figs. 16, 17 (1918).

4 Vinciguerra, *Ann. Mus. Stor. Nat. Genova*, XXIX, p. 246, pl. vii, fig. 4 [(1889).

5 Annandale, *Rec. Ind. Mus.*, VIII, p. 36 (1912).

Barbus phutunio, a widely distributed Indian species, is said to have been introduced into ponds in the Residency gardens at Imphal, in which alone it was found, as an ornamental fish.

Thus we see that the two important elements of the fish-fauna of the S. watershed are the endemic Manipur element and the Burmese element. The endemic element is chiefly confined to the hill-streams and strictly speaking is an isolated one. Some of the species (for example *Botia histrionica*, *Botia berdmorei*, *Macrones affinis*, *Nemachilus zonalternans*, *Lepidocephalichthys berdmorei*), which have so far been known only from a small number of specimens obtained in Burma, are among the commonest species of the Manipur Valley and are represented by large series in our collection.

LOCAL NAMES OF FISH AND THEIR ECONOMIC VALUE, ETC.

Nga is the ordinary word both in Burma and Manipur for fish; but it is never omitted by Manipuris, except in a few cases, when referring to a particular species. Even the large water-bug (*Belostoma indicum*), which Manipuris eat, is called *Nga-Ki-Hum*. Those fish that do not occur in the valley, but are found in the northern watershed, are called comprehensively *Ching-Nga* or "mountain-fish." For most of these species I could obtain no Manipuri name.

Most of the local names were checked in the field by calling them out to a party of fishermen and getting the corresponding fish. The meanings of the names were for the most part given to me by Tumba Singh, whose services were lent to us by the Political Agent. They were also confirmed by other persons, who knew the Manipuri language very well.

There was some difficulty in writing the local names in roman characters, because it was rather difficult to follow their sound, which is partly nasal. However, I was able to get a complete list of the Manipuri fishes in Hindi characters, which I can read myself, and the spellings of the various names may thus be regarded as fairly reliable.

The Manipuris are a very intelligent and observant people and in giving names to the various species have had some regard either for its habit, colouration or resemblance to other animals (*e.g. sarinkhoibi*=otter-mouthed). Thus all the species of Barilius are called *Nga-wa*, "air-fish," and all *Nemachilus* with vertical bands *Nga-tup*, "segmented-fish," and any striped fish *Nga-rang*, "striped-fish."

During my visit to Manipur I obtained a considerable amount of information regarding the local names of fish, their value as food and the method by which they are captured and cooked. In the table below I have given the names of all species from the area with which this paper deals, though in a few cases I have not been able to discover the local names or their meanings.

Serial No.	Scientific name.	Local name.	Meaning of the local name.	Economic value of the species and other particulars.
	Family SYMBRANCHIDAE.			
1	*Monopterus albus* (Zuiew).	*Nga puram.*	No explanation was given by the Manipuris. Kaboi Nagas call it *kha-roi*, snake-fish	Manipuris do not eat this fish, because, as they informed me, this name comes after those of all other eatable fish in their holy book, the Puranas. Nagas catch it by a two pronged spear and smoke it without salting.
	Family SILURIDAE.			
2	*Clarias batrachus* (Linn.).	*Nga-kara* ..	"Burnt black fish" The name refers to its black colour.	Fairly good eating. This is captured in large numbers in swamps by cutting the grass and scooping out the water.
3	*Wallago attu* (Schn.).	*Sareng* ..	"Big fish"	Good eating The biggest fish sold in the market.
4	*Callichrous bimaculatus* (Bloch).	*Nga tin*...	*tin* "to spit" or "a bow." The dorsal profile in this fish is like a bow; also, according to the Manipuris, the fish spits when taken out of water.	Fairly good eating. During the rainy season, its roe is ground and fried and is used in making a kind of flat cake.
5	*Macrones bleekeri*, Day.	*Nga-chep* ..	*chep* implies the habit of the fish when taken out of water. It shuts and opens its mouth constantly.	Fairly good eating. It is said to have few bones.
6	*Macrones* (*Macronoides*) *affinis* (Blyth).	*Nga-rang* ..	"Striped fish." The name is derived from *arangbah*. This adjective is used for other things also.	Good eating.
7	*Glyptothorax dorsalis* (Vinciguerra)	*Nga-pang.*	*pang* from *pangwa* "innocent." This implies the habit of the fish which does not dart away when disturbed but remains quietly in the same place and is easily caught.	It is said to be full of fat and oil.
8	*Glyptothorax minutus*, sp. nov			
9	*Gagata cenia* (Ham. Buch.).	*Nga-rang* ..	[See No. 6 above] ..	The Manipuris do not distinguish this species from *M. affinis*.
10	*Erethistes hara* (Ham. Buch.).	....	....	These species are not represented in our collection. They are known to occur in the Naga Hills.
11	*Erethistes elongata*, Day.			
	Family CYPRINIDAE.			
12	*Psilorhynchus* sp., Hora.	....	....	....
13	*Garra nasutus*, McClelland.	*Nga-mu-sangum.*	*mu* "black"; *sangum* "an umbrella" or "a mushroom" in reference to the mental disc. According to others *sangum* is an insect	Fairly good eating, said to be rich in oil.

Serial No.	Scientific name.	Local name.	Meaning of the local name.	Economic value of the species and other particulars.
			which lives in grass and by its bite produces a swelling.	
14	*Garra naganensis*, sp. nov.	....	....	....
15	*Garra abhoyai*, sp. nov.	....	....	....
16	*Garra rupiculus*, McClelland.	*Nug-nga* ..	"Stone fish" ..	Nagas eat it.
17	*Labeo calbasu* (Ham. Buch.).	*Paing-ba* or *Pemba.*	A fish with a red streak below the cheek and with red iris. *Pemba* denotes red.	Good eating but bony.
18	*Labeo angra* (Ham Buch.).	*Kha-bag.*	*kha*-mouth; *bag* denotes the fleshy appendages which surround the mouth.	Good eating. They are chiefly used for extraction of oil in which other fish and vegetables are fried.
19	*Labeo pangusia* (Ham. Buch.).	do.		
20	*Crossochilus latia* (Ham. Buch.).	*Nga-rohi* or *nga rohi mapi.*	*rohi* "round," in reference to the cylindrical form of the fish. The young are called *nga-rohi* and the adults *nga-rohimapi* the mother of *nga-rohi.*	The young are bitter in taste while the adults are slightly bitter but not bony,
21	*Barbus sarana caudimarginatus*, Blyth.	*Nga-noi* ..	*noi* "fat;" the young of this fish are called *nga-hau* at Wangjing village.	Full of bones; its flesh is said good flavour.
22	*Barbus oatesii*, Boulenger.	....	....	....
23	*Barbus clavatus*, McClelland.	*Samehet* ..	"Comb fish," in reference to the denticulations along the dorsal spine.	The fish was obtained at Kairong and only the Naga name is given here.
24	*Barbus tor* (Ham. Buch.)	....	....	....
25	*Barbus hexastichus*, McClelland.	*Huru* ..	"Restless fish," makes *hur-hur* agitation or trembling in the water.	Few people eat it fresh. It is generally dried in big trays and then ground into powder, which is used as a condiment like pepper with vegetables.
26	*Barbus ticto* (Ham. Buch.)	*Nga-kha* ..	*khaiba* "bitter." The Manipuris compared the taste of these fishes to that of a tobacco leaf.	
27	*Barbus conchonius* (Ham Buch.).	do. ..	....	....
28	*Barbus phutunio* (Ham. Buch.)	do. ..	....	....
29	*Rasbora rasbora* (Ham. Buch.).	....	....	....
30	*Rohtee belangeri* (C. and V.).	*Tharak* ..	"Flat and thin" ..	[See No. 17 above].
31	*Rohtee alfrediana* (C. and V.).	*Nga-shiksha*	"Compressed fish" ..	Fairly good eating.
32	*Barilius bendelisis* var. *chedra* (Ham. Buch.).		*wa* "air;" in reference to the surface feeding habits of the fish. At Kairong some Manipuris called it *nga-ra* on account of the blue bands on the sides of the body.	The intestine, which is also eaten, is said to be bitter. The fish is, however, good eating.
33	*Barilius barila* (Ham. Buch.).	*Nga-wa.*		
34	*Barilius dogarsinghi*, sp. nov.	do.		

Serial No.	Scientific name.	Local name.	Meaning of the local name.	Economic value of the species and other particulars.
35	*Danio dangila* (Ham Buch.).	....	...	....
36	*Danio aequipinnatus* (McClelland).	....	....	....
37	*Danio* (*Brachydanio*) *acuticephala*, sp. nov.	...	....	....
38	*Danio nagarensis*, Chaudhuri.	....	....	....
	Family Cobitidae.			
39	*Botia berdmorei* (Blyth).	*Sarin Khoibi*	"Otter-mouthed fish."	Very good eating.
40	*Botia histrionica*, Blyth	*Nga-rang.*	"Striped fish" in reference to its black and white colour.	do.
41	*Lepidocephalichthys guntio* (Ham. Buch.)	....	....	....
42	*Lepidocephalichthys berdmorei* (Blyth).	*Nga kshrou* or *Nga-ki-jarau*	*kshrou* "loose mud." The fish lives in loose mud hence the name. The second name signifies its slimy skin like that of a leech *javau.*	It is generally smoked, but people occasionally eat it fresh.
43	*Lepidocephalichthys irrorata*, sp. nov.	*Nga-nap* ..	*nap* denotes the action of pressing a thing between the fingers hence "a compressed fish."	Manipuris do not like it fresh and generally smoke it.
44	*Acanthophthalmus pangia* (Ham. Buch.).	*Nga-sang* ..	*sang* "thin and long"..	[See Nos. 25—28 above.]
45	*Nemachilus botia* (Ham. Buch.).	....	....	....
46	*Nemachilus zonalternans* (Blyth).	*Nga-rem* ..	....	....
47	*Nemachilus manipurensis*, Chaudhuri.	*Nga-sarva*	....	....
48	*Nemachilus kangjupkhulensis*, sp. nov.	*Laingoi-phumba* or *Sarin*	*phumba* "sand," the fish lives in sand and hence the name.	....
49	*Nemachilus sikmaiensis*, sp. nov.	*Nga-tup* ..	*tup* "segmented," in reference to the vertical band on the sides.	[See No. 42 above.]
50	*Nemachilus prashadi*, sp. nov.	do.		
	Family Percidae.			
51	*Ambassis ranga* (Ham. Buch.).	*Nga-mahi* ..	"Silvery fish" in reference to the colour of the abdomen.	Bony, not bitter.
	Family Nandidae.			
52	*Badis badis* (Ham. Buch.).	*Pona* ..	"Deep-black" ..	....
	Family Mastacembelidae.			
53	*Rhynchobdella dhanashorii*, sp. nov.	....	....	....
54	*Mastacembelus manipurensis*, sp. nov.	*Nga-rin* ..	"Snake-fish" ..	Fairly good eating. It is generally smoked.

al .	Scientific names.	Local name.	Meaning of the local name.	Economic value of the species and other particulars.
	Family OPHIOCEPHALIDAE.			
	Ophiocephalus harcourt-butleri, Annandale.	*Nga-mu* ..	"Black fish" ..	Fairly good eating, very common in swamps especially near the Loktak Lake.
	Ophiocephalus punctatus, Bloch.	....	....	....

Besides those fish given in the table above, there are others that visit the valley only during the rains. For convenience of reference I give their vernacular names, but as they are not represented in our collection I am unable to give their scientific equivalents.

Nga-mu-poram.—Imported for sale in a dried condition from Silchar.

Sna-nga=gold fish.

Nga-cha-hu or *Nga-chau.*—This fish is dreaded by local fishermen, because even a mild injury inflicted by its spine causes the swelling of all lymphatic glands, while a deep wound results in fever which may last for two to three days. It is said to be good eating

Nga-khro-bi.—This literally means "a fish with its mouth on the under surface." It is said to have a large upper lip.

Muglang.—This fish, like *nga-noi*, has a red operculum, caudal fin, belly, and streak of the same colour along the dorsal surface. Manipuri cartmen gave me this name for *Rasbora rasbora* at Dimapur, but I had no opportunity of verifying their statements from any other sources.

Nga-thi=ugly fish.

Nga-pa-hi.—The fish is said to hop like a sparrow.

Nga-hi=boat fish, in reference to its form like the Manipuri dugout.

Nga-len.—From *lenghba*=one that does not move. A remarkable account of the method of capture was given to me. The Mohammedan fishermen who alone capture and eat this fish dive and search for it under water. On discovering a fish, they come out and take a rope with them and dive again to the same place. They tie the rope round the tail of the fish being always careful not to touch its belly as this immediately disturbs it. The rope is now taken on shore and two or three people drag the fish out. It is said to be the most powerful fish in the valley.

For the following names I have no explanation:—*Nga-san*; *Nga-ril*; *Nga-chik*; *Nga-na-hi*; ; *Nga-nal*; *Nga-tin-charo*; *Nga-rel.*

The Manipuris do not take any other animal diet but fish, and practically all species found in the valley, except the *Nga-puram* and the *Nga-len*, to which they have a religious objection, are eaten. All are said to be more or less "bitter," when compared with the dried fish imported in large quantities from Sylhet, Cachar and from various other places. Below I have arranged the fish according to their food value as determined by Manipuris.

Good eating.—*Khabag*; *Sarin-khoi-bi*; *Sáreng*; *Nga-chep*; *Nga-rang*; *Nga-pang*; *Nga-chau*; *Nga-wa*.

Fairly good.—*Nga-rin*; *Nga–mu*; *Nga-kara*; *Nga-tin*; *Nga-mu-sangum*.

Fairly good but bony.—*Nga-tol*; *Nga-rohi-mapi*.

Very bitter.—*Huru*; *Nga-kha*; *Nga-sang*; *Nga-rohi*.

Smoked before eating.—*Nga-kshrou*; *Nga-nap*; *Nga-rin*; *Nga-tup*.

The fish sold fresh in the markets are :—*Nga-mu*; *Nga-kara*; *Nga-tin*; *Nga-chep*; *Sareng*.

Of these the first two are very common and are sold in a living condition in the market. The rest of the species except *Sareng* are also brought to the market dried. The major part of the freshfish sold in Imphal comes from Waithu-pat and the dried fish are mostly from the Thanga Island.

SYSTEMATIC DESCRIPTION OF THE COLLECTION FROM THE MANIPUR VALLEY AND THE NAGA HILLS.

Order **SYMBRANCHOIDEA**.

Family SYMBRANCHIDAE.

Monopterus albus (Zuiew).

1916. *Monopterus albus*, Weber and Beaufort, *Fishes Indo-Austr. Arch.*, III, p. 413, figs. 210, 211.

1918. *Monopterus albus*, Annandale. *Rec. Ind. Mus.*, XIV, p. 42.

Monopterus albus is found all over southern Asia east of the Bay of Bengal; its range extends to northern China and Japan.

The fish is only found buried in mud at the edge of the Loktak Lake. Some specimens were also found in the rice-fields in partially dried ponds. It is eaten by Nagas but not by Manipuris, who have certain religious scruples regarding the species. The Nagas, like the Inthas in the Inlé Lake, capture the fish with a two-pronged spear.

Cormorants, judging from the contents of their stomachs, seem to feed largely on this species.

Order OSTARIOPHYSI

Family SILURIDAE.

Clarias batrachus (Linn.).

1913. *Clarias batrachus*, Weber and Beaufort, *Fishes Indo-Austr. Arch.*, II, p. 190, fig. 74 (p. 187).
1918. *Clarias batrachus*, Annandale, *op. cit.*, p. 43.

This species is common everywhere in the valley, especially in and about the Loktak Lake. In the market it is usually sold in a living condition. Though the fish is very common in the swampy portion of the lake, it is also fairly abundant among the weeds further inwards. It does not grow to a very large size in the valley.

Adults are black in colour, but not quite so dark as young individuals. There are minute white spots forming distinct rows all over the body. The pectoral spine is roughened externally and finely serrated along its posterior border.

All the specimens in our collection are from the Loktak Lake.

Wallago attu (Schn.).

1889. *Wallago attu*, Day, *Faun. Brit. Ind. Fish.*, I, p 126 fig. 54.
1889. *Wallago attu*, Vinciguerra, *Ann. Mus. Stor. Nat. Genova*, (2) IX, p. 199.

This was the biggest fish brought to the Manipur market at the time of our visit. Waithu-pat, a lake on either side of the Burma Road some 10 miles from Imphal, is particulary noted for this species.

It is found throughout India, Burma and Ceylon.

Callichrous bimaculatus (Bloch).

1889. *Callichrous bimaculatus*, Day, *op. cit.*, p. 131, fig. 57.
1889. *Callichrous bimaculatus*, Vinciguerra, *op. cit.*, p. 201.
1919. *Ompok bimaculatus*, Jordon and Starks, *Ann. Carnegie Mus.*, XI, p. 434.

Young specimens of this species are very difficult to distinguish from those of *C. macrophthalmus* (Blyth). In the identification of the Manipur specimens I have followed Vinciguerra, though an examination of the collection in the Indian Museum has shown that much reliance cannot be placed on the character of the vomerine teeth.

The specimens in the collection were obtained from Imphal and Khurda streams and from the Loktak Lake. There is a great variation in colour even in specimens from the same locality. Some are silvery-white all over the body with a black blotch on either side above the pectorals ; while in others the body is densely covered with minute black spots on a dull-white background, and the mark above the pectorals is not distinct.

In the valley *C. bimaculatus* does not reach a larger size than 9 to 10 inches.

Macrones [1] bleekeri, Day.

1889. *Macrones bleekeri*, Day, *op. cit.*, p. 162.
1889. *Macrones bleekeri*, Vinciguerra, *op. cit.*, p. 219.

The adipose fin of this species has a very great resemblance to that of *M. cavasius* and *M. leucophasis*. The difference between the three species may be expressed in a table as follows :—

M. cavasius (H.B.).	*M. leucophasis* (Blyth).	*M. bleekeri*, Day.
Maxillary barbels reach the caudal fin.	Maxillary barbels reach the anal fin.	Maxillary barbels reach the anal fin.
A black spot at the base of the first dorsal spine.	The head and fore part of the body bright silvery-white; no black spot at the base of the first dorsal spine.	Light longitudinal bands along the body; sometimes with a black shoulder spot. In the Burmese examples a black spot is also present at the base of the caudal fin.
Depth of body $5\frac{1}{2}$ times in the total length.	Depth of body $4\frac{1}{2}$ times in the total length.	Depth of body $5\frac{1}{2}$ times in the total length.
No interneural bone.	An interneural bone present.	No interneural bone.

The fish is very common all over the valley and is captured in large numbers in traps, both in the streams and the lakes.

The specimens from the Loktak Lake are darker in colour.

Subgenus Macronoides, nov.

This new subgenus is proposed for species which differ from typical *Macrones* in the possession of a distinct ventral mouth bordered by fringed lips; in having short barbels not exceeding the length of the head; in the mandibular pairs of barbels being disposed in a transverse row across the mandible and in the possession of a number of open pores on the ventral surface of the head just behind the mouth. In general facies the fish of this subgenus show a remarkable resemblance to those of the genus *Gagata*, from which, however, they are easily distinguished by the crescentic band of teeth and a free air-bladder in the abdominal cavity.

I assign the following species to the new subgenus:—*Macrones affinis* (Blyth),[2] *M. dayi* Vinciguerra [3] and *M. marianiensis* Chaudhuri.[4] I have examined the types of the first and the third; while Vinciguerra's description and figures of *M. dayi* leave no doubt as to its affinity with the other two.

[1] Jordan, *Proc. Acad. Nat. Sci. Phil.* LXX, p. 341, considers *Macrones* a synonym of *Aoria*; but in view of the familiarity of the name *Macrones*, I have retained it in this paper.

[2] Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 150 (1860).

[3] Vinciguerra, *op. cit.*, p. 230, pl. vii, fig. 3 (1889).

[4] Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 253, pl. xi, figs. 1, 1*a*, *b* (1913).

The subgenus *Macronoides* is distributed in Burma, the Abor Hills and the Manipur Valley.

Macrones (Macronoides) affinis (Blyth).

1860. *Batasio affinis*, Blyth, *op. cit.*, p. 150.
1889. *Macrones blythii*, Day, *op. cit.*, p. 151.

The fishermen of Manipur do not make any distinction between this fish and *Gagata cenia*, both of which are called *nga-rang*. The body is dotted with black spots which are aggregated in certain regions to form 3 or 4 indistinct vertical bands. Both the adipose and the spiny dorsal are edged with black. The alimentary canal is simple and has only two coils in its entire length.

Reference may be made to the importance which has been attached to the number of serrations on the pectoral spine. I have, however, found on examining a large number of specimens that the number of serrations is variable not only in different individuals, but even in the spines of the two sides of the same specimen.

There are four specimens from Amambi stream near Karam Lakai, about 8 miles from Imphal on the Burma Road.

M. affinis is known from Burma and the Manipur Valley.

Glyptothorax dorsalis, Vinciguerra.

1889. *Glyptothorax dorsalis*, Vinciguerra, *op. cit.*, p. 240, pl. vii, fig. 4.

There are ten specimens of this species, five from the Imphal stream and the rest from Amambi stream, some eight miles from Imphal on the Burma road.

The maxillary barbels reach the posterior margin of the base of the pectoral fin; the upper surface of the head and body is tuberculated, the tubercles being arranged in longitudinal rows. The dorsal spine is roughened externally and is smooth along its inner border; that of the pectoral fin is flattened and has 11 denticulations internally.

Most of the female specimens are full of eggs.

The species is known from Burma and the Manipur Valley.

Glyptothorax minutus, sp. nov.

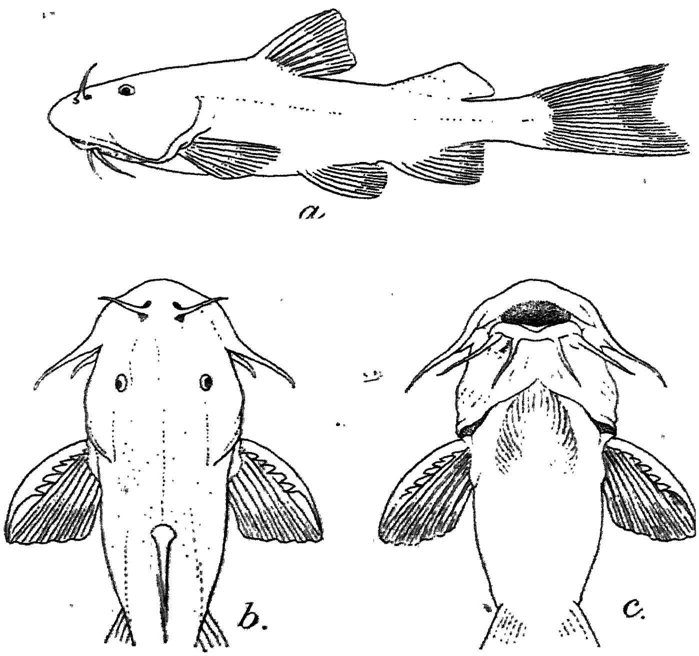
D. 1/6. A. 3/9.

The length of the caudal fin is contained $5-5\frac{1}{4}$ times, the depth of the body $5\frac{1}{3}-6$ times and the length of the head $5\frac{1}{2}-5\frac{3}{4}$ times in the total length including the caudal fin. The head is $1\frac{1}{4}$ times as long as broad. The eyes are minute, situated in the beginning of the posterior half of the head, they are dorsolateral in position and are not seen from the ventral surface. *Barbels.*—The maxillary pair reach the base of the pectoral, the nasals reach the eye, the inner mandibular reach the anterior

margin of the adhesive apparatus and the outer the gill membrane. *Fins.*[1]—The adipose fin is well developed; both the dorsal and the pectoral fins have loose folds of skin at their bases, the spine of the former is smooth while that of the latter is smooth externally and has six denticulations internally. The lower lobe of the caudal fin is slightly the longer.

The adhesive apparatus is U-shaped and is fairly well developed.

Colour.—The dorsal surface is dark, while the belly and the undersurface of the head are white; there are conspicuous black



TEXT-FIG. 1.—*Glyptothorax minutus*, sp. nov.
(*a*) Lateral view of adult fish, × 2½.
(*b*) Upper view of head of same, × 3.
(*c*) Lower view of head of same, × 3.

bands at the bases of all the median fins; the caudal is grey and the paired fins are colourless. A V-shaped whitish area is also present at the base of the dorsal fin.

Four specimens were obtained from the Imphal stream near Karong. Manipuris do not make any distinction between this species and the preceding one.

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[1] In giving the formula of the fin rays, I have attached great importance to the number of branched rays both in the dorsal and the anal fins. In the descriptions of the new species I have omitted the number of fin-rays in the caudal fin, because it is very difficult to count the smaller rays on either side after the longest ray. I have included, however, the length of the caudal fin in the total length.

Originally I regarded these specimens as the young of *G. dorsalis*, but on dissection I found the females full of eggs. Besides the smaller size, the species is distinguished from *G. dorsalis* by differences in the proportions of the body, the colouration and by the number of denticulations on the pectoral spine.

The largest specimen is 36 mm. in length.

Unfortunately the specimens are lost; but the figures clearly show all the features.

Gagata cenia (Ham. Buch.).

1889. *Gagata cenia*, Day, *op. cit.*, p. 208, fig. 75.
1890. *Gagata cenia*, Vinciguerra, *op. cit.*, p. 240.

This species is always confused by Manipuris with *Macrones* (*Macronoides*) *affinis*.

All the specimens from Manipur are young; they were only found in the Imphal and the Amambi streams.

The species is widely distributed in the waters of the Ganges and the Irrawadi.

Family CYPRINIDAE.

Psilorhynchus sp., Hora.

Plate IX, figs. 6, 6*a*.

1920. *Psilorhynchus* sp., Hora, *Rec. Ind. Mus.*, XIX, p. 211.

A few young specimens were collected in a small hill-stream at Piphima, Naga Hills.

Garra (Ham. Buch.).

Three species of this genus were discovered in the Manipur Valley and the Naga Hills by the survey party and myself. Of these two are represented by a large series in our collection while the remaining one, which is new, is known from a single specimen. In Mr. Pettigrew's collection there are three specimens of this genus. They represent another undescribed form.

The discussion on these species is given in another paper in which I am publishing a revision of the genus *Garra*. The names that I propose to give to the new species are included in the list for the sake of completeness.

Labeo calbasu (Ham. Buch.).

1889. *Labeo Calbasu*, Day, *op. cit.*, p. 259, fig. 93.
1889. *Labeo calbasu*, Vinciguerra, *op. cit.*, p. 265.

Only one specimen, 28·5 cm. in length, was obtained; it was captured in Khurda stream near its origin from the Loktak Lake.

The fins are much elongated. The ventrals are longer than the pectorals and reach beyond the base of the anal, which in turn extends beyond the base of the caudal fin. The dorsal fin has a fairly long base.

The colour is black all over except the under surface of the head and chest, which is dirty white.

Labeo pangusia (Ham. Buch.).

1889. *Labeo pangusia*, Day, *op. cit.*, p. 266.
1913. *Labeo angra*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 249.

The specimens of *L. pangusia* from Manipur have a black blotch at the base of the caudal fin and are apt to be confused with those of *L. angra*. They can be distinguished from the latter species by the possession of definite barbels instead of the maxillary flaps inside the grooves, one on either side of the mouth, and in having a triangular black spot just above the fifth scale of the lateral line. The structure of the mouth and lips of the two species is also different.

Labeo pangusia is common in the streams of the valley and three specimens were collected from the Loktak Lake. The lake specimens are darker in colour.

Labeo angra (Ham. Buch.).

1889. *Labeo angra*, Day, *op. cit.*, p. 267.
1889. *Labeo angra*, Vinciguerra, *op. cit.*, p. 273.

The specimens of this species agree with Burmese examples in our collection. They possess a fleshy flap inside the groove instead of the maxillary barbels on each side of the mouth. There is a deep black blotch at the sides of the tail. In certain young individuals there is also an indication of a second blotch above the middle of the pectoral fin.

The specimens in the collection were found in the muddy streams of the Manipur Valley.

Crossochilus latia (Ham. Buch.).

1889. *Cirrhina latia*, Day, *op. cit.*, p. 279.
1889. *Crossochilus latius* Vinciguerra, *op. cit.*, p. 280.
1918. *Cirrhina latia*, Annandale, *op. cit.*, p. 46.

This fish is found in abundance in the muddy streams of the valley, and does not exceed 7 inches in length.

The young specimens are slender in form and look somewhat different from the adults. Manipuris call the young *nga-rohi* and the adults *nga-rohi-mapi*, "the mother of *nga-rohi*."

This is one of the commonest species found in the streams of the Manipur Valley.

Barbus sarana caudimarginatus, Blyth.

1860. *Barbus caudimarginatus*, Blyth, *op. cit.*, p. 157.
1918. *Barbus sarana caudimarginatus*, Annandale, *op. cit.*, p. 46.

The species is fairly common in the Imphal River and its tributaries and is also found in the Loktak Lake. The lake specimens are, however, darker in colour.

Barbus oatesii, Boulenger.

1893. *Barbus oatesii*, Boulenger, *Ann. Mag. Nat. Hist.* (6) XII, p. 201.

Annandale[1] regarded this species as being synonymous with *Barbus sarana* var. *caudimarginatus*, Blyth, after comparing his specimens from the Inlé Lake with a cotype of Boulenger's *oatesii* and as a result of his examination of a series of specimens of *B. sarana* from India and Burma in the collection of the Indian Museum. In identifying my specimens I have referred to the same sources, and am convinced after a careful examination of the large series, that *B. oatesii* is a distinct species and that Annandale's own specimens undoubtedly belong to the true *B. sarana caudimarginatus*.

The most important difference between the two species is in the structure of the dorsal spine In *B. oatesii* it is strong and very strongly serrated, with 12 to 19 serrations on each margin of its posterior border. The serrations along the two margins of the spine are very close together and become longer and stronger from below upwards. In *B. sarana caudimarginatus* the spine is strong but finely serrated only in its upper half or two-thirds, the serrations are subequal. Along the posterior aspect, the spine is deeply grooved and the serrae are situated on its margins; their number is indefinite. The colour of the two species is also different. In both the forms, however, the opercular cleft has a black edge, which probably led to the confusion of the two species. In *B. oatesii*, as Boulenger observed, each scale is edged with black. This condition is not so well-marked in the cotype examined by Annandale, because the colour has become very faint on account of the specimen having been in spirit for over a quarter of a century. There can be no doubt regarding the colouration of the young specimens collected by me in Thaubal stream about a mile from Phaidai. Under a lens the black edge is seen to consist of minute black dots which are more closely aggregated along the anterior border of the scale.

The caudal fin is also different in the two species. In *B. oatesii* it is long and deeply notched, the lower lobe being broader and longer. In *B. sarana caudimarginatus* the caudal fin is relatively shorter in length, and is not so deeply notched. The two lobes are equal in length.

The proportions are also different in the two species.

In young specimens the length of the caudal fin, the depth of the body and the length of the head are almost equal and are contained $4\frac{1}{2}$—$4\frac{2}{3}$ times in the total length. The caudal fin is very brittle and is broken in most specimens. The following are the measurements of two complete young individuals:—

	A.	B.
Total length including caudal ..	53 mm.	57 mm.
Length of caudal	11 ,,	13 ,,
Depth of body	11 ,,	12·3 ,,
Length of head	12 ,,	12·7 ,,

[1] Annandale, *Rec. Ind. Mus.*, XIV, p. 46 (1918).

B. oatesii is now known from the S. Shan States and the Manipur Valley.

Barbus clavatus, McClelland.

Plate IX, fig. 1.

Barbus clavatus, McClelland, *Calcutta Journ. Nat. Hist.* V, 280, pl. xxi, fig. 2.
1868. *Barbus clavatus*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 97.
1878. *Barbus clavatus*, Day, *Fish. India*, II, p. 566.
1889. *Barbus clavatus*, Day, *op. cit.*, p. 300.

There has been some confusion between *Barbus chagunio* (Ham. Buch.), *B. spilopholus*, McClell. and *B. clavatus*, McClell. At first McClelland[1] considered *B. chagunio* to be "a variety of the spotted barbel, *B. spilopholus*," but later in describing *B. clavatus* he remarked that "the collection now before us, affords, however, a very distinct species, which I believe to be the *Cyprinus chagunio*, Buch." Günther regarded McClelland's two species as distinct, but placed *Cyprinus chagunio* with a query under the synonymy of *B. clavatus*. Day recognised *B. chagunio* as a distinct species and regarded *B. spilopholus* as its variety; he moreover considered *B. clavatus* as a distinct species. Chaudhuri[2] recognised *B. spilopholus* as a valid species, but had no material to decide about *B. clavatus* as it was then only known from McClelland's description which is unfortunately imperfect and meagre and some casual remarks in it are misleading; his figure of the species is also poor.

I take this opportunity to supply a short description and a figure of the species from a few well-preserved examples collected in Senapati stream near Kairong, Naga Hills, Assam.

D. 4/8. A. 3/5. P. 14—15. V. 8—9.

The length of the caudal fin equals the depth of the body which is contained 4—4½ times in the total length. The head is short and conical, its length being contained 5—5¾ times in the total length; it is comparatively longer in young specimens than in the adult. The snout is shorter than the diameter of the eye, which is contained about 3 times in the length of the head. The caudal peduncle is 1¾—2 times as long as broad. *Fins.*—The origin of the dorsal is almost in the middle of the distance between the end of the snout and the base of the caudal fin, in some individuals it is nearer to the former. Its last spine is denticulated posteriorly and is almost as high as the depth of the body below it. The free margin of the fin is deeply concave. The caudal fin is very long and deeply forked, its rays are very brittle. *Scales.*—There are 40—42 scales along the lateral line, 7—8 rows of scales above it and 3½—4½ below it to the base of the ventral fin. In an oblique line there are in all 11 rows between the bases of the dorsal and the ventral fins. There are 14

[1] McClelland, *Asiat. Resear.*, XIX, pp. 272 and 341 (1839).
[2] Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 250, pl. viii, figs. 1, 1*a*, *b* (1913).

scales in front of the dorsal. *Barbels.*—Both pairs of barbels are well developed Maxillary barbels are longer than the rostrals and are as long as the diameter of the eye.

The vent is much nearer the base of the caudal fin than the end of the snout.

The mouth is semicircular; its opening extends to the anterior border of the orbit. There are two rows of open pores on the under surface of the head. The snout is usually tuberculated, but in young individuals these tubercles are not developed.

The fish is blackish blue in the region above the lateral line, below it the sides and the ventral surface are dull white. The membranous portions of the skin between the rays of the dorsal fin are black in colour. The caudal along its superior and inferior margins is edged with black. The young specimens are brighter in colour and possess an obscure blotch at the base of the caudal fin. In some specimens the scales along the lateral line and of a few rows above and below it are covered by minute black spots, forming longitudinal bands along the side

Barbus clavatus is found in rivers at the foot of the Sikkim mountains on the northern frontier of Bengal and in the Naga Hills at Kairong.

Barbus hexastichus, McClelland

1889. *Barbus hexastichus*, Day, *op. cit.*, p. 308.
1889. *Barbus hexastichus*, Vinciguerra, *op. cit.*, p. 291.

Three grown up specimens were obtained at Kairong. They possess an indistinct black spot on either side of the tail. This character is best marked in the young fry collected at various places in small streams in the Naga Hills and also in Itok stream near Chanderkhong in the Manipur Valley.

Barbus tor (*s.l.*) (Ham. Buch.).

Only one specimen of this species was obtained from Senapati stream near Kairong, Naga Hills. The lips in the example are well developed and are provided with thick adipose growth.

Barbus tor is a composite species and I hope to deal with its races and species in a separate paper when sufficient material from various localities is available.

Barbus conchonius (Ham. Buch.).

1889. *Barbus conchonius*, Day, *op. cit.*, p. 325.

Numerous specimens of this species were collected in lakes and streams all over the valley.

Barbus phutunio (Ham. Buch.).

1889. *Barbus phutunio*, Day, *op. cit.*, p. 327.

Numerous specimens of *Barbus phutunio* were collected from the Residency ponds, Imphal. The following description of the

colour of the living specimens was noted down by Dr. Annandale in the field-book :—" The dorsal surface brownish, deeply tinged with metallic green and dotted with black, sides metallic crimson, each scale edged with black; ventral surface silvery; pelvic, anal and caudal fins crimson; dorsal and pectoral bright olivaceous green with the rays more or less infuscated and with black spots on the dorsal. Iris crimson, lower part of the cheek and operculum silvery white densely speckled with black.''

S. Dogar Singh informed me that these fish were introduced into the Residency ponds from outside the Manipur Valley on account of their beautiful colouration.

Barbus ticto (Ham. Buch).

1889. *Barbus ticto*, Day, *op. cit.*, p. 325.

This is the commonest fish in the valley and is daily captured in large quantities with baskets.

Rasbora rasbora (Ham. Buch.).

1889. *Rasbora buchanani*, Day, *op. cit.*, p. 337, fig. 107.

Only two specimens were captured from the Dhanashori stream, near Dimapur, Assam. In both specimens the scales have been rubbed off leaving the black edged membranes behind. The caudal fin is tipped with black as in the Burmese examples.

Rohtee, Sykes.

Some ichthyologists have adopted the generic name *Osteobrama*, Heckel, in preference to *Rohtee*, Sykes, probably owing to a confusion as to the dates of publication of the works of Heckel and Sykes. Günther in his "*Catalogue of the Fishes in the British Museum*," VII, p. 322, gives 1842 as the date of publication of the two works and selects *Osteobrama*, with Sykes' genus *Rohtee* as a synonym. Vinciguerra (*op. cit.*, p. 313) in adopting the same course writes as follows :—" Ho adottato il nome generico di *Osteobrama*, a preferenza di quello di *Rohtee*, perchè, mentre essi sono di data sincrona, poichè il lavoro di Heckel in cui il primo è proposto (Russegger's Reisen I, p. 1033) fu pubblicato nel 1842 data che porta anche quello di Sykes, in cui è stabilito il secondo (Trans. Zool. Soc. Lond. II, p. 364), quello ha sull'altro il vantaggio di non essere barbaro come esso." I do not agree with the authorities quoted above and find that Sykes' work was published on 27th February, 1841; while Heckel established *Osteobrama* in 1843. According to the rules of priority, therefore, *Rohtee* must have preference over *Osteobrama*. Vinciguerra's second argument for adopting *Osteobrama* is purely sentimental and therefore needs no consideration.

Another point deserving some consideration is, as to whether

Hamilton Buchanan's[1] eighth subgenus "*Cabdio*" of his *Cyprinus* should be revived in place of *Rohtee* or not, as it includes *Cyprinus* (*Cabdio*) *cotio* which is now regarded as a *Rohtee*. On a careful analysis of the subject, however, I find that *Cabdio* can not replace *Rohtee* because the forms assigned to *Cabdio* by Hamilton Buchanan include species which have subsequently been assigned to several genera and Sykes (1841) was the first to separate some species, in practice if not in theory, for in describing *Rohtee ogilbii* he observes as follows:—"The *Rohtee* has the appearance of *Clupanodon chanpole* of Dr. Hamilton; also of *Cyprinus devario* in the outline of the body; and were it proper to consider it a *Cyprinus*, which its armed back-fin renders impossible, it would be placed in Dr. Hamilton's eighth subgenus '*Cabdio*.'" Sykes in making the above remark ignored the fact that Hamilton Buchanan's *Cyprinus cotio* had a spine of this nature. Further, of the four species included under *Rohtee* by Sykes, two *viz. Rohtee pangut* and *Rohtee ticto* are now invariably referred to the genus *Barbus*, while of the other two belonging to *Rohtee* (s s) neither was known to Hamilton Buchanan. From the statements of the two authors it is clear, therefore, that *Cyprinus cotio* is congeneric with *Rohtee*, Sykes, which may stand for these and other similar species. I am highly indebted to Dr. N. Annandale and Dr. B. L. Chaudhuri for valuable suggestions on this point.

Rohtee alfrediana (C. and V.)

1889. *Osteobrama alfrediana*, Vinciguerra, *op. cit.*, p. 316.

The specimens of this species were collected in Khurda and Thaubal stream; the longest is 109 mm. in length. In young individuals the body is less deep and an indistinct black band is usually present behind the gill cover.

Rohtee belangeri (C. and V.).

1889. *Osteobrama belangeri*, Vinciguerra, *op. cit.*, p. 318.

This species is distinguished from the rest included in the genus *Rohtee* by the fact that the whole of the abdominal edge is sharp, whereas in others it is sharp behind the ventrals but flat and rounded in front of them. Moreover, the pharyngeal teeth in this species are armed with tubercles on their crowns; this character is shared by *R. ogilbii*.

It will not be out of place to make some observations on the nature of the pharyngeal teeth here. In a former paper by Annandale and myself[2] a reference was made to the occurrence of loose teeth in the muscles surrounding the pharyngeal bones. Having had the opportunity to dissect a large number of fish for these teeth, I find the loose teeth fairly common. In *R. belan-*

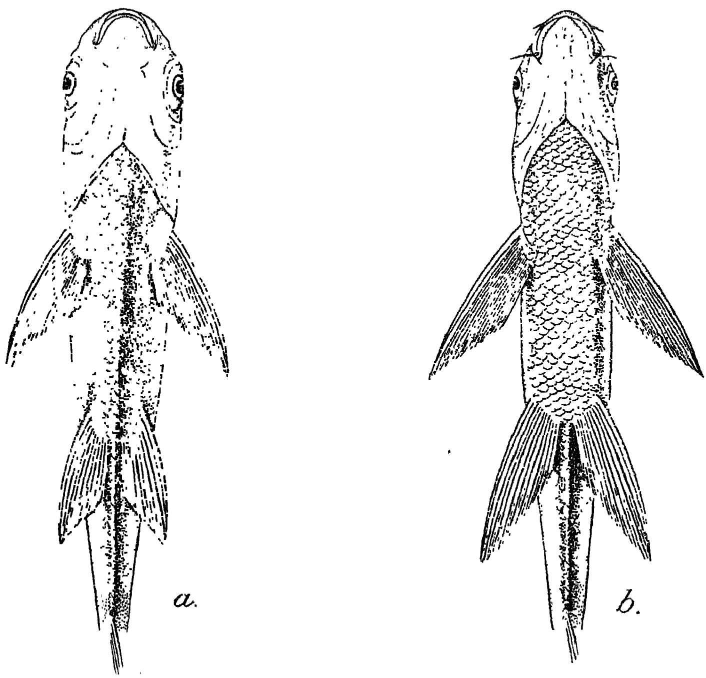
[1] Hamilton Buchanan, "*An account of the Fishes in the Ganges,*" pp. 333 and 392 (1822).

[2] Annandale and Hora, *Rec. Ind. Mus.*, XVIII, p. 165 (1920).

geri their crown is crenulated like that of the fixed teeth and in all probability they represent the older teeth that have been cast off and their place being taken up by new ones. Dr. Annandale thinks it more probable that the free teeth are young and have not yet fused with the bone.

Two specimens of this species were obtained from the Manipur Valley, one in Loktak Lake and the other in the Khurda stream. The lake example is darker in colour.

This species occurs in Burma and Manipur. Its occurrence in the Godaveri River needs confirmation.



TEXT-FIG. 2.—Ventral view of two species of *Rohtee*, Sykes.

(*a*) *Rohtee belangeri*, showing keeled abdomen throughout.
(*b*) *Rohtee feae*, showing keeled abdomen only between vent and base of ventrals.

Barilius bendelisis var. **chedra** (Ham. Buch.).

1889. *Barilius bendelisis* var. *chedra*. Day, *op. cit.*, p. 347.

This species is represented in our collection by seven specimens captured in the Senapati stream near Kairong, Naga Hills. The water of this stream was very clear and my attention was drawn to a fairly big specimen of this species, which showed beautiful colour and special mucous bands on certain parts of the body. The fish was very sluggish in habit and we followed it from place to place till it was secured in an ordinary hand net Out of water the mucous bands were not so distinct and in spirit have

left those particular portions of the fish lighter in colour. The colour of the fresh specimens is thus described in the field-book:—"The caudal fin and the apex of the dorsal dusky; other fins pinkish. The general surface silvery, with a black triangular spot at the base of each scale; the cheeks yellow; the operculum golden or deep orange with black borders."

The paired fins are broad and well-expanded and most of the outer rays in them have become stiff. The chest is flattened and the scales in this region are poorly developed. There are characteristic muscular pads in front of the bases of the pectorals. The open pores on the snout are absent.

Barilius bendelisis var. *chedra* is found along the base of the Himalayas.

Barilius barila (Ham. Buch.).

1889. *Barilius barila* Day, *op. cit.*, p. 348.

The character of the barbels on which Day has based his synopsis of the species of this genus is faulty; not only because the barbels are very small, but also because they are liable to be overlooked owing to their being hidden underneath folds of skin. In the Manipur examples both pairs of barbels are present, the rostral pair being slightly longer than the maxillary. There are 22 rows of scales in front of the dorsal fin The chief character on which I have based the identification of this species is the inequality of the two lobes of the caudal fin; the lower lobe being slightly the longer. This character is more marked in young individuals.

Barilius barila exhibits considerable variations with age and locality. In young individuals the pectorals do not reach the ventrals, nor the latter, the anal, and the origin of the dorsal is equidistant from the middle of the eye and the base of the caudal fin. With the growth of the fish, especially in hill-streams, the paired fins become much expanded and the area in front of the pectorals is specialized as in *B. bendelisis* var. *chedra*. In a specimen about 13 cm. long, the pectorals extend beyond the ventrals and the ventrals reach the anal, and the dorsal is equidistant from the hinder edge of the eye and the base of the caudal fin.

The vertical blue bands on the body are better marked in young specimens than in the adults. I have the following note in the field-book about the colouration of a living specimen from the Sikmai stream:—"Upper surface dark olivaceous, sides silvery with blue bands extending to the lateral line; fins pinkish; iris deep orange; opercular piece dark while the rest of the gill-cover orange."

A specimen from the Khurda stream is of special interest, because it lacks the ventral fins. The absence of the ventrals has been considered to be a character of generic importance, but in the case of this specimen I consider it an abnormality, as it is impossible to separate this individual on any other character from *B. barila*, of which I have examined a large series.

The following are the measurements of the unique specimen:—

Total length including caudal	94·0 mm
Depth of body	18·5 ,,
Length of head	19·0 ,,
Diameter of eye	6·0 ,,
Length of snout	5·5 ,,
Interorbital width	6·3 ,,
Length of rostral barbels	2·0 ,,
Length of maxillary barbels	1·5 ,,

The species is widely distributed in the streams of the valley. A few specimens were taken in the Senapati stream near Kairong in the Naga Hills.

Barilius dogarsinghi, sp. nov.

D. 2/7. A. 3/9. P. 13. V. 8.

The length of the head is contained 5—5⅓ times, the depth of the body 4—4⅓ times, the length of the caudal 5 times in the total length including the caudal fin. The eyes are situated somewhat in the anterior half of the head, their diameter being contained 4 times in the length of the head, 1¼—1½ times in the length of the snout and 1¼ times in the interorbital width. *Barbels.*—There are two pairs of short barbels. *Scales.*—There are 38—39 scales along the lateral line, 7—8 rows above it to the base of the dorsal fin and 3 below it to the base of the ventrals. There are 20 rows of scales in front of the dorsal fin. *Fins.*—The origin of the dorsal is equidistant from the end of the upper lobe of caudal and the anterior margin of nares. It is situated far back and extends to about the middle of the anal fin. The paired fins are well developed and possess a number of stiff rays. The pectorals do not reach the ventrals, which in some examples extend to the base of the anal fin. The auxiliary processes do not go beyond the bases of the pectorals. The free margins of both the dorsal and the pectoral fins are rounded. The lower lobe of the caudal fin is slightly longer than the upper.

The mandibular knob so characteristic of the genus is absent in this species.

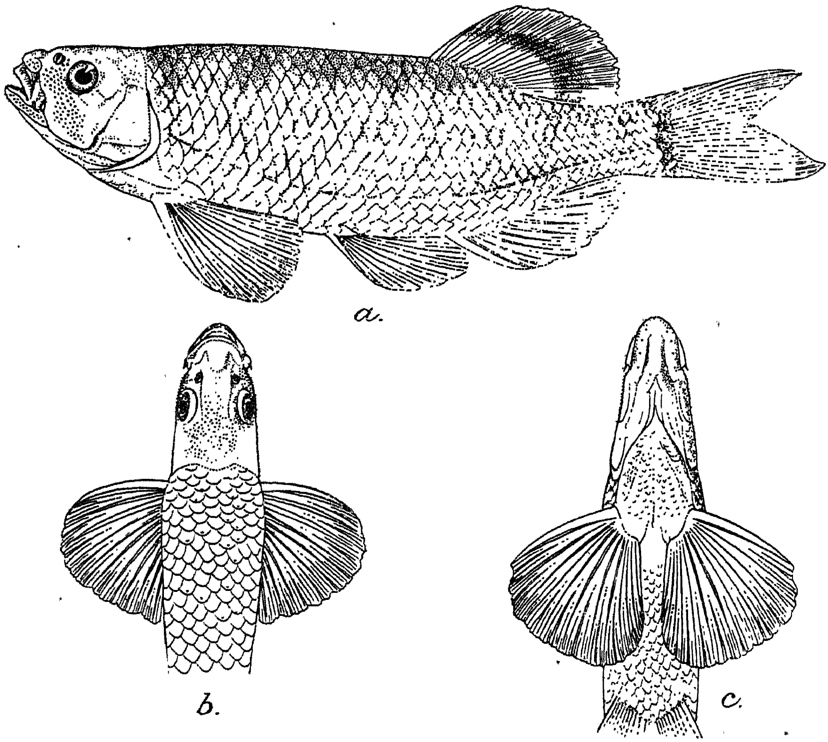
The dorsal profile in front of the dorsal fin is almost straight, but posteriorly it curves to the base of the caudal fin. The ventral profile is deeply arched and is convex throughout. The skin on the sides of the head is prominently tuberculate.

Colour.—The dorsal surface of the head and body is black with about 9 blue lateral bands. The band at the base of the caudal fin is deeper in colour than the rest. The belly and the under surface of the head, and the pectoral, the anal and the ventral fins white. The caudal is dusky in its posterior half, and the dorsal has a characteristic deep black band across its middle.

The young individuals have longer barbels, a smooth snout and normal paired fins, and the band at the base of the caudal fin shows a deep black spot in its centre.

As in the preceding species, I find that in one example the ventral fin of the left side is absent and the surface is covered with scales in the region from which the fin is lacking.

A specimen 85 mm. in length was found on dissection to contain eggs.



TEXT-FIG. 3.—*Barilius dogarsinghi*, sp. nov.

(*a*) Lateral view of type-specimen (slightly enlarged).
(*b*) Dorsal view of head of same (slightly enlarged).
(*c*) Ventral view of head of same (slightly enlarged).

I have great pleasure in associating this fish with the name of my friend S. Dogar Singh, State Overseer at the time of our visit to Manipur, who toured in the valley with me and helped me in various other ways.

Type-specimen.—F 9983/1. *Zoological Survey of India* (*Ind. Mus.*).

Twelve specimens of this species were captured in the Etok stream near Chanderkhong and one young individual in the Sikmai stream near Palel.

Barilius dogarsinghi is quite distinct from the rest of the species included in the genus in the form and position of the vertical fins and in its general facies. It might perhaps be regarded as the type of a new genus or subgenus, but, for the present at any rate, I prefer to place it in *Barilius*.

Danio dangila (Ham. Buch.).

1889. *Danio dangila*, Day, *op. cit.*, p. 356.
1889. *Danio dangila*, Vinciguerra, *op. cit.*, p. 306.

Two specimens were found at Ghaspani (alt. 1500 ft.). The largest specimen is 58 mm. in length.

Danio dangila is found in Bengal, Bihar, Darjiling, Burma and the Naga Hills.

Danio aequipinnatus (McClell.).

1889. *Danio aequipinnatus*, Vinciguerra, *op. cit.*, p. 304.

Specimens of this species were captured in various streams in the Naga Hills and three from a small hill-stream north-west of Potsengbaum and one from Itok stream near Chanderkhong.

I have the following note in the field-book on the colouration of a living specimen caught in a small stream near Ghaspani:—"Three blue bands on either side—the one in the middle reaching the base of the caudal fin which is infuscated in the middle. Intervening between these blue bands are others of a yellowish-orange colour. The blue bands break up behind the operculum and form a characteristic pattern. There is a black spot behind the angle of the operculum and a golden streak runs along the dorsal surface. The fish is partially transparent with a dusky back and a white belly. The caudal and the pectoral fins are reddish; the dorsal is provided with a blue stripe. The remaining fins are of an orange colour."

Danio (Brachydanio)[1] acuticephala, sp. nov.

D. 2/6—7. A. 2—4/9.

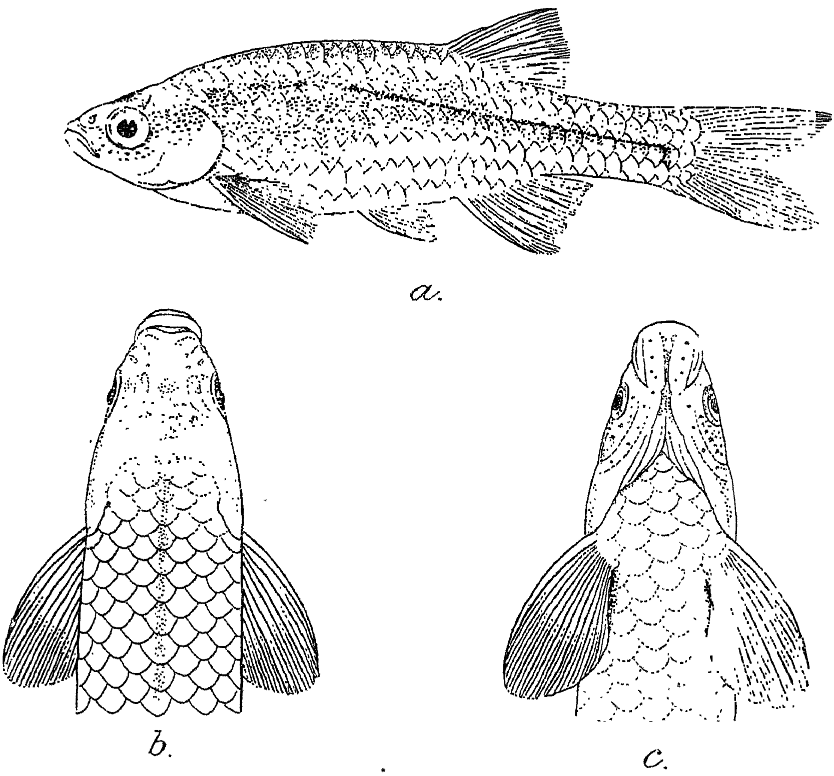
This little fish is fairly stout and deep and has a characteristic facies, being highest in the middle and tapering towards both ends. The head is short and pointed. The eyes are prominent and are situated in the anterior half of the head. The mouth is small, semicircular and is turned upwards. The nostrils are placed midway between the antero-superior margin of the eye and the end of the snout. There are open pores distributed all over the head and those on the under surface are along the preopercular borders and the mandibles. In some specimens the pores are absent.

The dorsal fin is short with 6—7 branched rays, its origin is equidistant from the end of the snout and the hinder end of the

[1] Weber and Beaufort, *Fish. Indo-Austra. Arch.*, III, p. 85 (1916).

caudal fin. The pectorals are rounded and when adpressed do not reach the ventrals, which in turn do not extend to the base of the anal. The anal fin is truncate and its base is covered with a scaly sheath. The caudal fin is deeply emarginate both the lobes are pointed, the lower one slightly the longer. Both the pectoral and the ventral fins are provided with scaly appendants.

The length of the head is contained $4\frac{2}{3}$—5 times and the length of the caudal $4\frac{1}{4}$—$5\frac{1}{4}$ times in the total length including the caudal fin. The diameter of the eye is contained 3—$3\frac{1}{2}$ times



TEXT-FIG. 4—*Danio* (*Brachydanio*) *acuticephala*, sp. nov.

(*a*) Lateral view of type-specimen, × 2.
(*b*) Dorsal view of head of same, × 3.
(*c*) Ventral view of head of same, × 3.

in the length of the head. There are 30 scales along the lateral line and 8 rows in an oblique line between the bases of the dorsal and the ventral fins.

Colour.—In the specimens preserved in spirit the upper surface is dusky and the lower pale-olivaceous. A broad black longitudinal band is present on either side of the body and a black narrow streak is to be seen along the dorsal surface.

The colour of a fresh specimen from Bishenpur, Manipur, is thus described in the field book :—" Upper part of body dull olivace-

ous, speckled with black, dorsal surface of head and a narrow line extending all along the dorsal surface of the body, black. A metallic bluish line running along the middle of each side. Sides of head silvery speckled with black. Ventral surface as far as the vent, white and silvery. Lower part of body behind the vent tinged with salmon, fins white, minutely speckled with black and an obscure salmon stripe along the centre of the caudal."

Type-specimen.—F 9981/1. *Zoological Survey of India (Ind. Mus.).*

Danio acuticephala is widely distributed in the small streams and ponds of the valley. It does not occur in big muddy streams.

Measurements in millimetres.

	Type	A.	B.	C.	D.
Total length including caudal	44·8	42·4	29·7	39·2	41 5
Length of caudal ..	8·5	9·7	7·0	8·4	8·2
Depth of body ..	10·8	9·8	6·5	9·1	10·0
Length of head ..	9·3	8·8	6·4	7·9	8·3
Diameter of eye ..	2·6	2·5	2·1	2·3	2·5

Most of the female specimens were found to be full of eggs.

Family COBITIDAE.

Botia berdmorei (Blyth).

1860. *Syncrossus berdmorei*, Blyth, *op. cit.*, p. 166.
1889. *Botia berdmorei*, Vinciguerra, *op. cit.*, p. 345.

Numerous individuals of this species were collected in the Imphal River and its tributaries in the valley.

Vinciguerra points to the inconsistency as regards the number of barbels in Day's description of the species. I have examined the type-specimens and a large series of individuals from the Manipur Valley and in all I have been able to make out only six barbels, four of which are rostral and united at their base. The arrangement of the rostral barbels and the structure of the lower lip is very characteristic of the species.

The colour varies greatly. Usually there are 10—18 oblique transverse bands on the body and about 5 longitudinal rows of black dots. The upper surface of the head is black, with two black streaks running from the eye to the snout. The belly and the under surface of the head are white. In one specimen the body was uniformly pale except for light bands on the caudal fin.

Botia berdmorei occurs in Burma and the Manipur Valley.

Botia histrionica, Blyth.

1860. *Botia histrionica*, Blyth, *op. cit.*, p. 166.
1889. *Botia histrionica*, Vinciguerra, *op. cit.*, p. 346.

Only two specimens of this species were obtained from the Amambi stream. They are 118 and 153 millimetres in length.

The Manipur examples agree with Vinciguerra's description of the species except for a little variation in colour which is, otherwise, characteristic of the species. In the younger specimen the number of bands on the caudal and the dorsal fins are fewer in number and in the adult black dots are present between the vertical bands on the body.

Measurements in millimetres.

Total length (including caudal) ..	153	118
Length of caudal	32	25
Depth of body ..	30	21
Length of head ..	30	22
Diameter of eye	5	3·8
Length of snout ..	18	13
Height of dorsal fin	20	15
Length of pectoral	23	18
Length of caudal peduncle	21	12
Height of caudal peduncle ..	19·5	14

Botia histrionica is only found in Burma and the Manipur Valley.

Lepidocephalichthys guntea (Ham. Buch.).

1889. *Lepidocephalichthys guntea,* Vinciguerra, *op. cit.*, p. 339.

There is only one specimen of this species taken at Ghaspani (1527 ft.) at the base of the Naga Hills, Assam.

Lepidocephalichthys berdmorei (Blyth).

1889. *Lepidocephalichthys berdmorei*, Vinciguerra, *op. cit.*, p. 341.
1918. *Lepidocephalus berdmorei*, Annandale, *op. cit.*, p. 43.

This is the commonest loach in the valley being found everywhere, both in the muddy and the hillstreams of the valley. It was curious to note that not even a single specimen of this species was obtained in the Loktak Lake, whereas it was quite common in a sluggish muddy stream near Potsengbaum.

The chief character that distinguishes this species from the preceding one is the mandibular flap. The mandibular flap in *L. berdmorei* is thickened and pliated anteriorly while posteriorly it is produced into three or more short barbel-like processes.

Lepidocephalichthys irrorata, sp. nov.

Plate IX, figs. 5, 5*a*, 5*b*.

D. 2/7. A. 3/5. V. 1/6. P. 7—8. C. 15—16.

This comprises small fish with the body slightly compressed from side to side. The dorsal profile is slightly arched while the ventral is straight and horizontal throughout. The length of the head is contained $6\frac{2}{5}$—$7\frac{2}{5}$ times, the depth of the body

$6\frac{1}{3}$—$7\frac{1}{3}$ times in the total length including the caudal fin. The eyes are minute and are situated in the anterior half of the head. The suborbital spine is bifid, the posterior prong being longer and stronger. The mouth, which is situated on the ventral surface, is semicircular and is provided with thick lips. The vent is placed on a slightly raised papilla and is provided with thick lips, which are not continuous posteriorly. It is situated in the beginning of the posterior third of the distance between the base of the caudal fin and the eye. There are two nostrils on each side lying close together but separated by a valvular flap. The anterior nostril is oval while the posterior is rounded. *Barbels.*—There are eight barbels, two rostral pairs, one maxillary pair and one pair mandibular. The bases of the mandibular barbels are broadened outwards to meet those of the maxillary barbels and thus a membranous flap stretches between the bases of the mandibular and the maxillary barbels. In some individuals the membranes are wanting and all the barbels are free. Under the lens the barbels show spiny projections all over their surface. *Fins.*—The dorsal fin is almost as high as the depth of the body below it; its origin is considerably behind the ventrals and is much nearer to the base of the caudal fin than to the end of the snout. The origin of the ventral is equidistant from the end of the snout and the base of the caudal fin. The free posterior border of the caudal fin is concave. *Scales.*—The scales are minute and there are about 34 rows in an oblique line between the base of the dorsal and that of the ventral fins.

The specimens from the Loktak Lake have a characteristic colouration. They are pale olivaceous, more or less densely speckled with black There is a series of fine dark spots running along each side. On the dorsal surface and the sides of the head the dark specks are more closely aggregated. The fins are whitish with numerous dark transverse bars on their rays; narrow, irregular pale bars are also to be seen on the dorsal surface. There is also a dark streak from the eye to the snout.

The specimens from other lakes and streams in the valley are of a uniform pale colour, with short bars across the back and a row of fine spots along the sides. The fins are banded or speckled with black dots.

Type-specimen.—F 9904/1. *Zoological Survey of India* (*Ind. Mus.*).

Lepidocephalichthys irrorata is widely distributed in the lakes and streams of the Manipur Valley.

Acanthophthalmus pangia (Ham. Buch.).

1889. *Acanthophthalmus pangia*, Day, *op. cit.*, p. 222.
1889. *Acanthophthalmus pangia*, Vinciguerra, *op. cit.*, p. 347.
1916. *Acanthophthalmus pangia*, Weber and Beaufort, *op. cit.*, III, p. 31.

In describing *Barilius barila* I referred at some length to an abnormal specimen in which the ventrals were totally absent and it

was pointed out that this character did not seem to me of either specific or generic value. The genus *Apua* is distinguished from *Acanthophthalmus* by the absence of the ventral fins. Vinciguerra does not recognise the genus *Apua*, but in doing so he does not assign any valid reasons. According to him "le ventrali fossero mancanti per pura accidentalitá o che per la loro estrema piccolezza sieno sfuggite all' osservazione di entrambi questi naturalisti." I have examined the two type-specimens (No. F $\frac{2047}{1}$) of *A. fusca*, Blyth, but can find no trace of the ventrals in them; and cannot, therefore, agree with Vinciguerra when he says that the ventrals must either have been overlooked or accidentally broken in the unique type-specimens of the genus. I look upon these cases as abnormalities, though it is surprising that both the specimens should have lost the ventrals. I have already referred to an abnormal specimen of *Barilius dogarsinghi* in which the ventral fin of the left side is absent. I have also examined a specimen of *Rita rita*, in the collection of the Government College Museum, Lahore, in which the pectoral fin of one side is absent. In view of what I have stated above I do not regard *Apua* as a distinct genus.

There is another interesting observation which might be referred to in this connection. After a careful examination of a large collection of *A. pangia* from Manipur, I am of the opinion that the form hitherto known as *Apua fusca* is only a hill-stream phase of *A. pangia*. Vinciguerra distinguishes *A. pangia* from *A. fusca*, by the greater depth of its body, by the ventrals being placed midway between the base of the caudal and the middle or the posterior margin of the orbit, and by the position of the dorsal, which in *A. fusca* ends just above the origin of the anal fin. I have not been able to verify the above characters in the case of the type-specimens of *A. fusca*. In these specimens the dorsal fin is in advance of the anal, and its origin is not equidistant from the base of the pectoral and the end of the caudal fin. It arises in the posterior $\frac{1}{4}$ of the body.

The specimens from the hill-streams like Sikmai, Amambi, Phaidinga, etc., are slender, elongated and less deep, while those from the muddy streams are stouter and deeper. The muddy stream forms possess a soft dorsal fin like that of the genus *Adiposia*.[1]

The structure of the soft dorsal fin of *A. pangia* is very simple. The wall consists of a thin layer of epithelium and of a muscular layer internal to it. There are no specialized gland-cells and the muscular sheath consists of fine fibrils running transversely. The inner core consists of a highly vacuolated tissue, supplied with a few blood vessels which lie in the middle. The muscles do not run across the dorsal muscles but are continued along the body-wall.

[1] Annandale and Hora, *Rec. Ind. Mus.* XVIII,, pp. 183—186 (1920).

It is unfortunate that the collection of *A. pangia* in the Indian Museum is very poor. There is only one specimen No. 2590 from Mandalay and even that has been allowed to desiccate and is not fit for examination. I am, therefore, unable to decide whether the two species should be united until further collections from various parts of India are available for examination.

The largest specimen in our Manipur collection is 60 mm. in length. On dissection the females were found to contain eggs.

Acanthophthalmus pangia has a very wide range, extending over North Eastern Bengal, Manipur, Shan States, Burma to Java and Sumatra.

Nemachilus manipurensis, Chaudhuri.

1912. *Nemachilus manipurensis* Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 443, pl. xl, figs. 4, 4*a*, 4*b*, and pl. xli, figs. 1, 1*a*, 1*b*.

Numerous specimens of this species were collected in the Auwlok and the Maklang rivers in the Kangjupkhul Hills; also a large number of specimens from Kangjupkhul *pukhri* (pond) behind the inspection bungalow.

Except for slight variation in the colour of some specimens, they argee with Chaudhuri's description of the species.

Nemachilus botia (Ham. Buch.).

1889. *Nemachilus botia*, Day, *op. cit.*, p. 227.
1919. *Nemachilus botia*, Annandale, *Rec. Ind. Mus.*, XVI, p. 127.

A single specimen 68 mm. in length was obtained at Ghaspani among the Naga Hills. The specimen is provided with a free orbital process below the eye and is probably a male. The lower lip is interrupted in the middle and is provided with characteristic cushion-like swellings.

Nemachilus botia is widely distributed all over northern and central India and also occurs in the Shan Plateau.

Nemachilus zonalternans (Blyth).

Plate X, figs. 3, 3*a*.

1860. *Cobitis zonalternans*, Blyth, *op. cit.*, p. 172.
1889. *Nemachilus zonalternans*, Day, *op. cit.*, p. 232.

This species is one of the commonest fish found in the Manipur Valley. Of 112 specimens, 77 are females and the rest males. The sexual dimorphism exhibited by this species is like that found in *N. botia* and consists in the males having a groove in front of the eye and a movable process of the preorbital bone.

N. zonalternans has hitherto been known from two specimens from Tenasserim. Both of these specimens are in the collection of the Indian Museum. One of these has been allowed to dessicate and the second one is not in a good condition for detailed examination. Moreover as the descriptions of Blyth and Day are meagre, I take this opportunity of writing a short note on the type-speci-

mens and a description of the species from fresh specimens, together with figures.

Having been long in spirit, the type-specimens have lost their natural colouration, except for certain markings on the caudal fin. There is also a faint black ocellus at the upper portion of the base of the caudal fin. The upper jaw is provided with a prominent knob in the middle. The lower lip is interrupted in the middle. The dorsal is considerably in advance of the ventrals. The lateral line is incomplete, ending below the origin of the dorsal. The eyes are nearer to the snout than the posterior extremity of the head.

Measurements of type-specimens in millimetres.

		A ♀	B ♀
Length of body (caudal excluded)	..	30·4	26·8
Length of head	.. ..	7·3	6·4
Diameter of eye	.. ..	1·9	1·6

The following is a description of the fresh-specimens from Manipur:—

D. 3/9—10. A. 2/5. P. 11. V. 7.

The length of the caudal fin is contained $4\frac{4}{5}$—5 times, of the head $4\frac{4}{5}$—$5\frac{1}{4}$ times and the depth of the body $5\frac{1}{4}$—$6\frac{1}{3}$ times in the total length including the caudal fin. The diameter of the eye is contained 4—$4\frac{1}{3}$ times in the length of the head and $1\frac{2}{3}$ times in the length of the snout. *Barbels.*—There are six barbels, two rostral pairs and one pair maxillary. The maxillary barbels are slightly longer than the outer rostrals and are $1\frac{1}{2}$ times as long as the diameter of the eye. The inner rostrals are equal in length to the diameter of the eye. *Fins.*—The dorsal fin arises in advance of the ventrals and is almost as high as the depth of the body below it; its origin is nearer to the snout than to the base of the caudal fin. The caudal fin is slightly emarginate, with the upper lobe slightly the longer. The caudal peduncle is almost as high as long.

The mouth is small and semicircular and the mouth-opening reaches to just below the nostrils. The lips, the jaws, and the lateral line are as described in the type-specimens.

The colour of this loach has thus been described by Blyth and agrees with the Manipur specimens:—"It has a dark lateral streak, crossed by twelve short transverse bands, which alternate with about the same number of dorsal dark cross-bands. The dorsal fin is marked with three and the caudal with four rows of black spots; the other fins being spotless." There is, however, considerable variation even in specimens from the same locality. Some are uniformly pale and in some the dorsal surface is black and the belly white. There is always a black ocellus near the superior margin of the base of the caudal fin.

Nemachilus zonalternans is known from Tenasserim district (Burma) and is common all over the Manipur Valley.

Some female specimens on dissection were found to contain eggs.

Measurements in millimetres.

	♀	♀	♀	♂	♂	♂
Total length including caudal	40·0	40·0	40·7	36·3	40·8	35·7
Length of caudal ..	7·6	8·2	8·1	7·2	8·9	7·3
Length of head ..	8·1	8·3	7·8	7·5	8·2	7·0
Depth of body ..	7·6	7·0	7·2	6·1	6·4	5·3
Diameter of eye ..	2·0	1·9	1·8	1·8	1·9	1·6

Nemachilus sikmaiensis, sp. nov.

Plate IX, fig. 4; plate X, figs. 1, 1*a*.

D. 2/8. A. 2/5. P. 11—12. V. 8.

In this fish the head is slightly depressed and the ventral profile is almost horizontal. The dorsal profile rises gradually from the end of the snout to the base of the dorsal fin, beyond which it slopes gradually to the base of the caudal fin. There are definite rows of open pores all over the head and those just above and below the eye meet posteriorly and are continued along the lateral line, which ends just above the middle of the anal fin.

The length of the head is contained 5—5$\frac{1}{5}$ times, of the caudal fin 5—5$\frac{2}{5}$ times and the depth of the body 7—8 times in the total length. The eyes are minute and are situated in the middle of the head. They look upwards and outwards and are invisible from below. The diameter of the eye is contained 4$\frac{1}{2}$ times in the length of the head. There are two pairs of nostrils, one on either side. Their position is nearer to the eye than to the end of the snout. A fold of skin, provided with a sharp, barbel-like process, separates the nostrils of each side. It has an inferior, semicircular mouth, which is surrounded by thick lips. The lower lip is slightly notched in the middle and is devoid of any swellings or papillae. *Barbels.*—There are six barbels, two rostral pairs and one pair maxillary. The outer rostrals are the longest and extend to the posterior margin of the nostrils. *Fins.*—The dorsal fin is slightly in advance of the ventrals and is as high as the depth of the body below it; its origin is equidistant from the nostrils and the base of the caudal fin. The pectorals are rounded and are shorter than the head and are separated from the ventrals by three-fourths of their own length. The ventrals are well developed and are provided with scaly appendages to their bases. The ventrals reach the vent. The caudal fin is deeply forked; the lower lobe is slightly the longer.

The colouration of this species is very characteristic. There are 12—13 black rings round the body, separated by an equal number of slightly narrow white ones. In front of the ventrals the rings are incomplete and the under surface of the head and body is dull white. There is a black bar across the base of the

caudal fin and a black spot at the base of the first few dorsal rays. The rays of the dorsal fin have black markings along their length in the middle. The caudal fin is dusky and the rest spotless. In some examples the rings in the anterior portion are hardly distinguishable and the colour has become uniformly black.

The males of this species are provided with a thick, triangular pad below the antero-inferior margin of the eye.

Nemachilus sikmaiensis is distinguished from the rest by the simplicity of its lips, by the nature of the caudal fin which is deepy forked, by the fact that the lateral line does not extend beyond the middle of the anal fin and that the dorsal fin possesses only eight branched rays.

Type-specimens.—F 9932/1. *Zoological Survey of India* (*Ind. Mus.*).

Only nine specimens of this species were obtained in the Sikmai stream near Palel on the Burma Road.

Measurements in millimetres.

	♂	♀	♀	♀	♀
Total length including caudal..	41·3	43·3	31·4	33·0	32·5
Length of caudal ..	7·2	8·1	6·3	6·3	6·2
Length of head ..	8·2	8·3	6·4	6·4	6·3
Depth of body ..	5·8	6·2	4·2	4·2	4·1

Nemachilus kangjupkhulensis, sp. nov.

Plate X, figs. 4, 4*a*.

D. 2/6—7. A. 2/5. V. 6—7. P. 9.

In this species the dorsal profile is slightly arched and the ventral is horizontal throughout. The head is bluntly pointed and slightly depressed. The under surface of the head and body is flat. There are open pores scattered all over the head, and a row of these just below the eye is continued along the lateral line. It has a ventral mouth, which is situated only a short distance behind the anterior end of the snout and is surrounded by thick lips. The upper lip is slightly notched and the lower widely interrupted in the middle. Behind the lower lip there is a cushion-like muscular pad, resembling the central callous portion of the disc of *Garra*. The lower lip is slightly fimbriated.

The length of the head is contained $5\frac{1}{5}$—$5\frac{3}{5}$ times, of the caudal 6—$6\frac{1}{2}$ times and the depth of the body 6—$8\frac{1}{3}$ times in the total length including the caudal fin.

The eyes are dorso-lateral in position and their diameter is contained $5\frac{1}{2}$ times in the length of the head. The snout is twice as long as the diameter of the eye. The caudal peduncle is $1\frac{1}{5}$ times as long as high. *Lateral line.*—The lateral line is incomplete and ends before the commencement of the dorsal fin. In some examples it extends to just above the end of the pectoral

fins. *Nostrils.*—There is a pair of nostrils on each side and their position is nearer to the eye than to the tip of the snout. *Fins.*—The dorsal commences almost opposite the ventrals; its origin is equidistant from the anterior margin of the orbit and the base of the caudal fin. It is almost as high as the depth of the body below it. The pectorals are shorter than the head and are separated from the ventrals by their own length. The ventrals do not reach the vent, which is situated on a raised papilla and is provided with thick lips. The caudal fin is slightly emarginate and in some examples the lower lobe is longer than the upper. The bases of the ventrals are provided with fleshy pendants.

There are seven to eleven broad black bands on the body separated by an equal number of white ones which are only half as broad. There is a black bar at the base of the caudal fin and a black spot at the base of first three rays of the dorsal. In some examples the bands in the anterior region get mixed up and the surface becomes uniformly dusky. The under surface of the head and body is white. Usually there are two black streaks radiating from the eye to the snout.

I have not been able to discover any outward signs of sexual dimorphism in this species. Some specimens on dissection were found to contain eggs. The eggs in this species are fairly big. In a specimen 43 mm. long, the diameter of an egg is 1·8 mm.

Nemachilus kangjupkhulensis is widely distributed in the hill-streams of the Manipur Valley.

Nemachilus prashadi, sp. nov.

Plate X, figs. 2, 2*a*.

D. 4/8. V. 8. A. 6. P. 11.

The length of the head is contained 5—5½ times, of the caudal fin $4\frac{4}{5}$—5 times and the depth of the body 5—7 times in the total length including the caudal fin. In ripe females the greatest depth of the body is contained 5 times in the total length. *Eyes.*—The eyes are invisible from below and their diameter is contained $3\frac{4}{5}$—5 times in the length of the head. *Barbels.*—There are six fairly long barbels, the inner rostrals extend to the nasal opening and the outer reach the beginning of the second third of orbit. The maxillary barbels are as long as the outer rostrals and are twice as long as the diameter of the eye. *Lateral line.*—The lateral line is well-marked anteriorly, gradually it fades away and ultimately disappears behind the anal fin. *Fins.*—The dorsal fin is in advance of the ventrals and its origin is nearer to the snout than to the base of the caudal fin. The pectorals are longer than the head and when adpressed almost reach the base of the ventrals which are provided with a short fleshy pendant. The caudal fin is deeply forked and in some female examples the upper lobe is slightly the longer. The caudal peduncle is 1¼ times as long as high. In mature females the pectorals do not reach the ventrals.

The open pores, noticed in the preceding species, are present all over the head and are continued along the lateral line as well. There is a well-marked prominence in the middle of the upper jaw and the lower lip is interrupted in the middle.

The lateral line is crossed by 13 short, black vertical bands. Above the lateral line the body is marked by a characteristic reticulum formed by numerous dark bands and blotches. The under surface of the head and body is pale olivaceous. There is a deep black bar at the base of the caudal fin and two dotted bands across it. The dorsal fin is marked by two bands and a black spot at the base of the first few rays. The remaining fins are spotless or in some examples very indistinctly marked.

The specimens of *Nemachilus prashadi* were obtained in Thonagpal tank and in Thoubal and Sikmai streams. Of 74 specimens, 40 are males and the rest females.

I have great pleasure in associating this fish with the name of my friend Dr. Baini Prashad, Assistant Superintendent, Zoological Survey of India, who has given me every possible encouragement in my work in the Museum.

Type-specimen.—F 9987/1. *Zoological Survey of India* (*Ind. Mus.*).

Order ACANTHOPTERIGII.

Family PERCIDAE.

Ambassis ranga (Ham. Buch.).

1889. *Ambassis ranga*, Vinciguerra, *op. cit.*, p. 163.

The individuals of this species from different localities show considerable variation in colour. Those from the Loktak Lake are dirty yellowish-orange, shot with minute black dots all over. These dots are aggregated to form 6—11 transverse bands on the body. A similar arrangement of dots forms a black blotch over the shoulder. The upper portion of the iris and the head are stained with black. In the young individuals the transverse bands are absent. The specimens collected in streams are lighter in colour and do not show any black dots, though in some cases the transverse bands are well marked.

Family NANDIDAE.

Badis badis (Ham. Buch.).

1889. *Badis buchanani*, Vinciguerra, *op. cit.*, p. 166.

There are altogether three specimens of the species, two of which were captured in Dhanashori stream and one in a small pool in thick jungle near Dimapur, Assam. In colouration the fish agree with Day's description of the Assamese specimens.

This species is said to occur all over India and Burma, but I did not get a single specimen of it in Manipur.

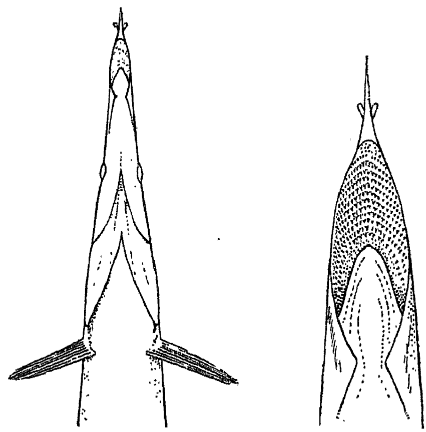
Family MASTACEMBELIDAE.

Rhynchobdella dhanashorii, sp. nov.

Plate IX, fig. 2.

D. 19/45. A. 3/47. C. 16. P. 17.

The length of the head is contained 7 times, of the caudal 14 times and the depth of the body $9\frac{1}{3}$ times in the total length including the caudal fin. The diameter of the eye is contained about 5 times in the length of the head. The vent is situated nearer to the base of the caudal fin than to the tip of the snout. The mouth is small and does not extend to below the nostrils. There are no preorbital or preopercular spines. The fleshy appendage of the snout is broad and concave with transverse striations on the under surface. *Fins.*—The first dorsal consists of nineteen spines, which increase in length posteriorly except for the last one which is shorter than the rest. It commences at the beginning of the second third of the distance between the anterior end of the orbit and the base of the caudal fin. There are three anal spines close together, the middle one is the longest. The caudal fin is free both from the dorsal and the anal fins.



TEXT-FIG. 5.—Under surface of head and snout of *Rhynchobdella dhanashorii*, sp. nov.

This species has a well-marked colouration. In spirit it is dull olivaceous speckled with numerous very characteristic pale lines extending downwards and forwards from the base of the dorsal fin and becoming obscure in the belly region. Behind the vent these lines are joined together in an irregular manner to form a reticulation. A pale longitudinal band extends backwards from behind the eye and becomes obscure in the post anal region. The lower surface is pale, speckled with black on the lower surface of the head. The fins are dark, minutely banded or speckled with dull white.

The only other known Indian species of the genus is *Rhynchobdella aculeata* which is said to occur in brackish waters within tidal influence and also throughout the deltas of large Indian and Burmese rivers. The new species differs from it in having a characteristic colouration and different proportions and also in the fact that *R. dhanashorii* occurs far inland in freshwater.

Type-specimen.—F 9989/1. *Zoological Survey of India (Ind. Mus.).*

A single specimen of this species was obtained in Dhanashori stream, about a mile from Dimapur, Assam.

Measurements in millimetres.

Total length including caudal	..	98·0
Length of caudal fin	..	7·0
Depth of body	..	10·5
Length of head	..	14·0
Diameter of eye	..	3·0

Mastacembelus manipurensis, sp. nov.

Plate IX, fig. 3.

The proportions show considerable variation with the age of the fish. In a specimen about 23 cm. long, the depth of the body is contained 9 times in the total length and the length of the head about 6 times. In an older specimen 44 cm. in length, the depth of the body is contained 13 times and the length of the head 7 times in the total length. The diameter of the eye is contained 7—11½ times in the length of the head. The vent is situated much nearer to the base of the caudal fin than to the end of the snout; its position can thus be located in the older specimen :—

Distance of vent from end of snout	..	22·7 cm.
,, ,, ,, base of caudal fin	..	19·6 ,,
,, ,, ,, end of caudal fin	..	21·0 ,,

The preorbital spines are absent, but there are three well-marked preopercular spines which increase in length from below upwards. The fleshy appendage to the snout is short and is 7 mm. in length in the older specimen. *Fins.*—The caudal fin is completely united with the dorsal and the anal fins. The spiny portion of the dorsal consists of 37 spines and commences above the middle of the pectoral. The rayed portion of the dorsal is leathery and low, so it is rather difficult to count the number of rays with exactness. There are, however, 66—72 soft rays. The anal fin has three spines close together, the middle one is the longest and the stoutest. The anal spines can only be made out after a careful dissection. There are about 50 rays in the anal fin.

In the older specimen, the dorsal surface of the head and body and the whole of the tail portion is black, with about 23 short black bands across the dorsal surface. The colour of the body below the lateral line and on the under surface of the head is pale olivaceous, gradually fading into yellow on the ventral surface. There are four irregular dark longitudinal bands on either side of the body, commencing from near the head and becoming indistinguishable in the region behind the vent. There is a characteristic dark band along the midventral line extending from the

head to the vent. On the sides and the under surface of the head there are short irregular bands forming a reticulum. There is a short band between the eye and the base of the pectoral fin. The pectoral is marked with a few dotted bands.

The following short description may be given to facilitate the identification of the species according to the synopsis of the species of the genus given by Boulenger [1] :—

Snout scaly on the sides; three anal spines; caudal completely united with dorsal and anal; vent considerably nearer caudal than end of snout; preorbital spines absent; 3 preopercular spines present; dorsal fin with 37 spines; mouth extending to below nostrils in adults while it does not extend so far in the younger specimen.

By these characters the new species approaches *M. erythrotaenia*, Blkr. and *M. caudatus*, McClell. From the former it differs in having 3 instead of 4 preopercular spines and in having fewer rays to the soft dorsal and the anal fins and also in colouration and proportions; from the latter in the fact that the mouth does not extend to below the anterior third of the eye and the number of rays both in the dorsal and the anal fins is not so great.

Since his synopsis, Boulenger has described three new species of the genus *Mastacembelus*, viz. *M. moeruensis*,[2] *M. stappersii* and *M. mellandi*.[3] I have consulted the descriptions and do not find any close affinity with the new species.

Type-specimen.—F 9990/1. *Zoological Survey of India* (*Ind. Mus.*).

Only two specimens of this species were obtained in Khurda stream, near Thanga Id.

Measurements in millimetres.

	A.	B.
Total length including caudal	440	129
Depth of body	35	14
Length of head excluding fleshy snout	64	21
Diameter of eye	5·5	3
Length of snout excluding fleshy portion	18·5	7·2
Length of caudal	21	4
Length of pectoral	19	6·7

Family OPHIOCEPHALIDAE.

Ophiocephalus punctatus, Bloch.

1889. *Ophiocephalus punctatus*, Vinciguerra, *op. cit.*, p. 186.

Only one specimen of this species was obtained in a dirty pool in thick jungle near Dimapur, Assam.

[1] Boulenger, *Journ. Acad. Nat. Sci. Philadelphia* (2) XV, pp. 197—203 (1912).
[2] Boulenger, *Rev. Zool. Africaine*, III, p. 446 (1913—14).
[3] Boulenger, *Ann. Mag. Nat. Hist.* (8) XIV, p. 386 (1914).

In *O. punctatus* the subopercular bones overlap or come very close to each other on the under surface of the head. The body is sharply marked into two regions, the upper surface of the head and the body is dark, while the belly and the lower surface of the head are white. There is a dark band along the side of the head from the snout to the angle of the operculum. There are also a number of alternating bands above and below the lateral line. The belly and the under surface of the head are speckled with black dots. There is a white transverse bar at the base of the caudal fin and all the fins have dotted bands.

Ophiocephalus harcourt-butleri, Annandale.

1918. *Ophiocephalus harcourt-butleri*, Annandale, *op. cit.*, p. 54, text-fig. 2; pl. ii, fig. 7; pl. iv, figs. 16, 17.

Specimens from the Shan States show great variation as regards the number of fin-rays both in the dorsal and the anal fins. Dr. Annandale gives the formula as:—D. 28—38. A. 16—25. The specimens of this species from Manipur are, however, constant as regards this character. Of a large number of specimens in which I counted the rays, only in one case was the number of rays in the dorsal fin found to be 35, while 34 is the rule. The anal fin always had 23 rays. Both types of colour-forms occur in our collection and the young individuals are characterized by a black ocellus at the base of the pectoral fin, followed by a number of black lines. In almost all cases the vertical and the caudal fins have a narrow reddish-orange band along their edge.

Ophiocephalus harcourt-butleri is widely distributed in the Southern Shan States (Burma) and the Manipur Valley. In the Manipur Valley it is common in the Loktak Lake and in the marshes surrounding it.

FISHERIES OF THE MANIPUR VALLEY AND OF THE NAGA HILLS OF THE SOUTHERN WATERSHED.

Owing to their religious tenets the Manipuris are forbidden any kind of animal food except fish, which thus forms a very important item in their diet. In the Loktak Lake, where traps and other fishing appliances are used in great variety, the state does not levy any kind of tax, consequently near Thanga Island, which may be described as the headquarters of the fishermen, fishing is carried on throughout the year and at all hours of the day and night, and every Manipuri irrespective of age and sex is engaged in fishing. Even in other places it is a common sight to see young boys and girls catching small fish from ponds with baskets. *Lai*[1] Manipuris do not spare even the molluscs and *Acrostoma variabile*, the soft parts of which are sucked out after boiling, is highly esteemed.

[1] *Lai*=Villagers. The Manipuris of the big towns look upon villagers as of low caste and usually do not mix with them.

From the fisheries in other areas, the state realises a good income. The total is estimated to be between Rs. 60,000 and 1,00,000 annually. The main rivers of the valley are divided into stretches, each about a couple of miles in length. The fishery rights in each of these areas are publicly auctioned every year and each fishery fetches from Rs. 400 to 500. The money is paid to the state in instalments; but usually, as I gathered from a talk with Mr. A. C. Eleazar, the full amount is never realised. The Waithu-pat, a lake some ten miles from Imphal and lying on either side of the Burma Road, is the most important centre, not only because it brings an income of Rs. 8,000 to 10,000 a year, but because the entire supply for the Imphal market of the big edible fish (*Wallago attu*) comes from this place.

Fishing Boats.

The only type of boat used in the Loktak Lake is a dug-out. It generally consists of a single piece of wood with a flat bottom, hollowed out to form a boat. The anterior end is broad and somewhat squarish. The boat is rowed with a single paddle having a long blade. A small boat costs from Rs. 15 to 18. Near Thanga Island some big boats are also used for fishing and as a means of transportation. In the Imphal River, the tradesmen also use big boats which are not dug-out but real flat-bottomed boats of similar shape.

Manipuris are very fond of boat-racing. During the rainy season, a racing competition is held every year in the Imphal River. On this occasion two big boats are used with dragons carved on their sides.

Fish-traps.

A series of characteristic traps are used in running water for capturing large quantities of fish. A trap consists of three parts, each performing a definite function. The first part consists of a superficial dam, built of bamboo poles and dry grass and extends almost across the stream, leaving only a passage for boats. The function of this dam is to prevent floating weeds and other debrís from choking the traps which are laid further on. About twenty yards below this dam, another stronger dam is built of the same material, but here the grass is held together by sticky mud. It does not come quite up to the surface, and the water either flows over it or through the boat passage. To the upper edge of the poles, just at the level of the water, numerous traps are fixed close together. Each trap consists of two parts. The *chora-ruh* or the upper part has the form of a conical tube and is attached by its wider end to one of the poles. The second portion or *lusak* is also conical but is closed at the narrow end. It telescopes a little over the end of the first part and is attached to it by means of a string. The *lusak* thus acts as a sort of a purse for all the fish that enter the trap and is detached from time to time and emptied of its contents.

By this elaborate arrangement all the fish crossing the dam near the surface are trapped.

The third dam is built about twenty yards still further down and is designed for the capture of bottom-fish which pass the second dam through the boat channel. It is only about a foot or so high from the bottom of the stream and is built across the whole of its breadth. Above the surface of the water the only traces of this dam are three pairs of strong bamboo poles firmly fixed in the ground; a pair is placed in the centre of the stream and one on each side of it near the bank. To the dam itself a series of spindle-shaped traps is attached. The *Kalio-ruh* is a spindle-shaped trap pointed anteriorly, and having an opening at the posterior broader end; this opening is plugged when the trap is laid. The entrance into the trap is on the under surface and consists of a conical tube made of bamboo splints; at the inner end these splints are sharply pointed so that a fish once it has passed into the trap is unable to get out again. The arrangement for keeping the trap in position is illustrated on plate xii, fig. 7. For this purpose strong bamboo pegs (*auúng*) about 46 cm. in length are employed. Each is made by doubling a length of bamboo on itself and thus possesses a loop at its upper end. One peg is thrust into the dam on each side of the trap and the two are lashed together by grass which is passed through the loops. Each trap is also secured by a length of bamboo with pointed ends which is bent over the trap and driven into the ground on either side. The double peg thus formed by the length of bamboo is called *chikap*. Under the *chikap* and all around it tufts of grass are woven in order to give the whole arrangement the appearance of an impassable barrier.

After every four or five hours the traps are taken out and emptied of their contents which frequently consist of a very large number of fish. The method of taking out the trap is rather peculiar. A long bamboo pole is thrown across the stream and is held in position by two of the three pairs of bamboo poles already mentioned. A rope is now tied to a boat and is passed along the horizontal bamboo pole. A man dives, releases the *chikap* on one side and brings out in turn the *kalio-ruh* in this region and passes them on to another man in the boat, who empties them of their contents by removing the plug at the broader end of each. When all the fish are jerked out the plug is replaced and the trap again set in position. This is a very successful and elaborate method and maunds of fish are daily trapped in this way.

The *kao* (pl. xii, fig. 1) is another kind of trap used in shallow streams. It is stuffed with grass and dry sticks and tied to a bamboo peg driven into the bank. Fish seeking shelter get amongst the grass and sticks and remain there. The trap is allowed to remain in the water for two to three days and is then rapidly dragged out. The fish are unable to free themselves quickly and are thus easily secured.

A *kao* which was seen in use in the Wang-jing stream near the village of the same name was 2 ft. 2 in. in height, 5 ft. in length and 6 ft. broad.

The fish generally caught in this trap are *Crossochilus latia* and *Botia berdmorei*, besides smaller species such as *Barbus ticto* and *Lepidocephalichthys irrorata.*

The *tikhau-ruh* or "trap of the Assamese" is the biggest trap used in the streams of the valley. It is circular, pointed at one end and with a funnel-shaped passage of bamboo spikes converging inwards at the other end. A strong bamboo pole is lashed to one of its sides for the attachment of ropes. Two ropes are used, one is tied to the closed narrow end of the trap and the other to the pole. A *tikhau-ruh* seen in the Imphal River was 7·5 ft. in length and 2½ ft. in diameter. The funnel was 2¼ ft. in length and the bamboo pole 3½ ft. The length of the ropes varies according to the stream in which the trap is used (pl. xii, fig. 4).

The method of using the trap is interesting and throws some light on the breeding season of Manipur fish. The open end is placed down stream during the months of February and March, whilst during September and October the same end is placed pointing up stream. According to the Manipur belief, the fish ascend the streams during February and March and descend during September and October. In using the trap, a long bamboo pole is fixed vertically in the middle of the stream. A rope from the narrow end of the trap is tied to the pole, while the broader end is attached by a second rope to a peg on the bank.

Many other varieties of traps are used in the Loktak Lake. These, however, do not differ from those commonly used in Bengal and which have been described by Anderson.[1]

Other characteristic traps are used by the Nagas and Manipuris for catching small hill-stream fishes. The *lo-lu* (pl. xii, fig. 3) of the Nagas is a funnel-shaped trap, with the narrow part greatly elongated and slightly dilated at the end. The bamboo sticks, of which it is made, have a spiral twist and are held in position by cane strings which run spirally from one end to the other. It is used in places where there is an abrupt fall in the water level. In such places the trap is fixed by means of a cane string and a peg, with its broad end pointing up stream. The narrow end is plugged with grass and small fish travelling with the current are carried into the trap. Owing partly to the rapidity of the flow of water and partly to the fact that they are confined in the narrow neck of the trap, they are unable to escape.

The Manipuri *lo-lu* (pl. xii, fig. 2) is similar but shorter and more massive. Instead of a single cane string it has two which are tied to two pegs one on either side of the small channel of water in which it is used. The Manipuris often use this kind of trap in their rice-fields, where the water from a field at a higher level flows to another at a lower level.

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[1] Anderson, *Cat. Fish. Appliances, Bengal.* (1883).

BASKET APPLIANCES.

Only two kinds of baskets are used for catching fish in the valley and one is of a type only to be found in the country bordering on the Loktak Lake.

The *lóng* (pl. xi, fig. 6), which is widely used all over the valley is bowl-shaped and is made of coarsely woven bamboo strips. The circular brim of the basket is formed of strong bamboo tied to the lower net-like portion by cane strings. A man using the basket dips it into the water and then disturbs the grass in front of it with his feet. The fish are thus driven in the basket which is, then, suddenly taken from the water and the catch transferred to an earthen pot which is carried tied to the waist. One of the baskets was measured to be 47 cm. in diameter and 31 cm. in height.

The second type of basket, the *chigai-lóng* (pl. xi. fig. 5) is saucer-shaped and is generally provided with a bamboo handle, the *machai*. The basket is shoved underneath a floating island and the grass is disturbed from above. It is then quickly withdrawn and small fish and insects are taken from it. It is chiefly used for collecting insects for baiting purposes. One I examined was 85 cm. in its longest diameter, 12 cm. in depth and the length of the handle was 200 cm.

I may here refer to a peculiar type of basket which is used for scooping out water. In marshy places the thick grass is cut with a long sickle and removed. The water is then scooped out with the basket, the *ishto-machai* (pl. xi, fig. 3) and the wriggling fish are caught with the bare hands. This method is employed for capturing *Ophiocephalus harcourt-butleri* and *Clarias batrachus*. The measurements of one seen at Thanga Island were: length of the handle 140 cm., the length of the basket 95 cm. and the depth of the basket 17 cm.

NETS.

Besides the cast net and the big seine net, the well-known *maha-jal* of India, there are three peculiar types of nets which may be briefly described.

The *lungtharai machai* (pl. xi, fig. 4) is like the shallow basket-net, *chigailong-machai*. It is extensively used among *Hydrilla* plants on the Potsengbaum side of the Loktak Lake. A long bamboo pole is used for disturbing the weeds and for throwing them off the net. The net without the handle or *machai* is also used like the *lóng* in various marshy places in the valley.

The most characteristic net is the *ilb-hungen-paura* of the Manipuris. It consists of a rectangular net 7 to 8 ft. long and 3 to 4 ft. wide. The net is spread out by two bamboo arches placed diagonally across it, each arch consisting of two pieces tied together in the middle. Where they cross, the arches are lashed together by a cane string in such a way that they can be folded together when the net is separated from them. A long bamboo pole is tied to the junction of the arches. In the Loktak Lake

the net is used by women from a boat. The bamboo pole is held between the thighs and is alternately raised and lowered by a peculiar movement of the right leg and both hands. In each boat there are two women, one of whom manipulates the net while the other rows the boat and drives the fish into the net by beating the boat with a short bamboo stick. The peculiar noise thus produced is to be heard day and night at Thanga Island.

The arrangement and the method of using the net is different in other parts of the valley. A rope is tied to the bamboo pole near the junction of the two arches and the pole is loosely fixed in the ground to serve as a fulcrum. The net is lowered or raised by means of the rope. With this arrangement the net is called *ilb-jung-thauri* (pl. xi, fig. 1.).

A kind of gill-net is also used in the Loktak Lake. Large pieces of pith tied along the upper edge act as a float, while the lead-weights attached to the lower edge keep the net vertical. The net is shot in a suitable place; the boats manoeuvre in the vicinity, herding the fish into the net, in which they are meshed.

All kinds of nets used in the valley are provided with a small mesh only a few millimetres in width.

FISHING ENCLOSURE.

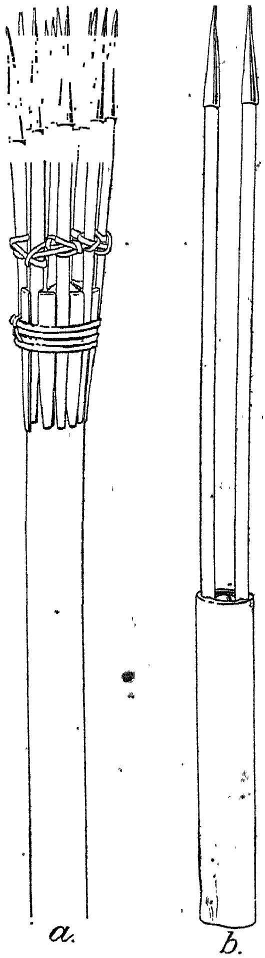
Big fishing enclosures are constructed in the Loktak Lake and sometimes large quantities of fish are captured in this way. A fairly big piece of a floating island is cut and drifted away to a suitable place and is fixed in position by passing long bamboo poles through it into the bottom of the lake. The island thus fixed is allowed to remain in one position for several days. After some time an enclosure of bamboo poles and grass is built around it, a little higher than the level of the water to prevent fish from jumping out. On the completion of the enclosure the floating island is cut into small pieces and cleared, but all the small fish which may be present in the grass are carefully collected. After the surface is cleared of floating material, the water is made muddy by making buffaloes move in it in all directions. Different kinds of nets are used for taking the fish out, the most efficient being the *ilb-hungén-paura*.

Near Thanga Island it is a common sight to see young boys and girls paddling a small piece of floating island to their homes by placing their small boat across it. Near their home the island is fixed in position by long bamboo poles and serves to attract fish by reason of the shelter it provides.

FISH SPEARING.

The spears used in the valley are of two kinds, one with two prongs, the other with several (as many as eleven or more). The former is used in spearing *ngapuram* (*Monopterus albus*), and is known as the Naga *laou*. It consists of two long bamboo sticks bearing iron prongs at one end and tightly fixed by wedges at

the other end inside the hollow of a thicker bamboo which forms the handle. The handle of the spear is about 8 inches in length while the total length is five feet. The Manipuri *laou* is constructed on an entirely different plan. It consists of a fairly long and thick bamboo pole, at one end of which several short sticks with iron prongs at their ends are firmly fixed. Some of these are fixed inside the hollow of the pole, just as in the Naga *laou*, but others are tied all round it with a cane lashing. Bamboo splinters are wedged in between the prongs to keep them in position. This spear is chiefly used for catching big fish in the Loktak Lake. When a fisherman sees some disturbance in the grass, he throws his spear at the place. I was given to understand that as big nets cannot be used in the lake on account of the thick vegetation, all the large sized fish are captured with this spear.



TEXT-FIG. 6.—Drawings of models of fish spears.

(*a*) Manipuri *laou* for spearing ordinary fish.

(*b*) Naga *laou* for spearing eels.

HOOKS AND LINES.

I did not see any fishing-rods in use in Manipur, but I was informed that a crude type of rod is used in the valley. Peculiar bamboo hooks, sometimes tied at intervals to a long line were seen in use in the Loktak Lake. The hooks consist of thin bamboo splinters sharpened at both ends and notched in the middle for the lashing. They are very flexible and the bait, which consists of worms and insects or of small species of *Barbus*, is put on by bringing the two ends together. The efficiency of the hook depends upon the elasticity of the bamboo, for as soon as the fish has swallowed the bait, the hook opens out; the ends penetrate the side of the mouth, often protruding through the gill openings. Several scores of these hooks are used in making a line.

EXPLANATION OF PLATE IX.

Fish from Manipur.

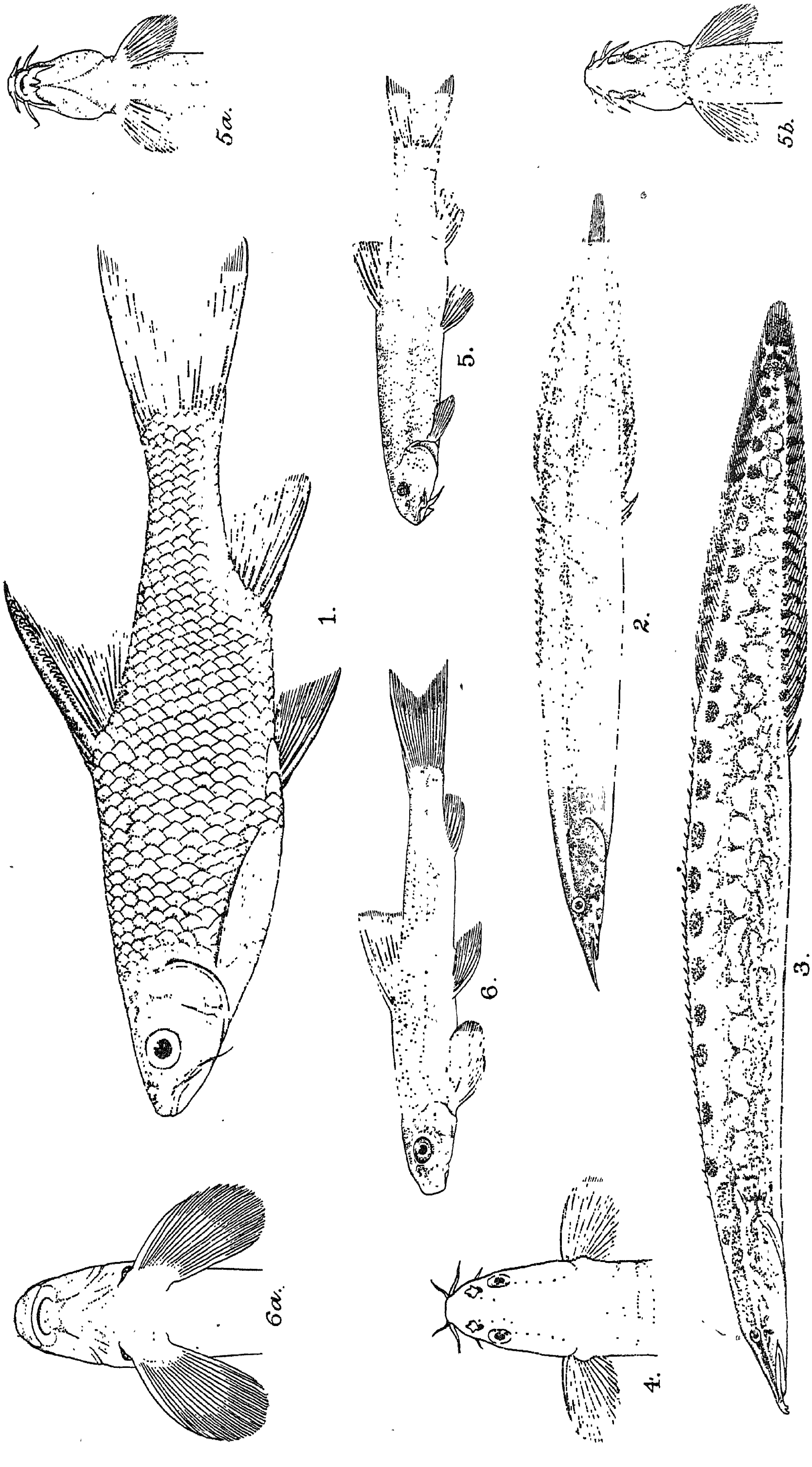
FIG. 1. Lateral view of *Barbus clavatus*, McClell., (reduced).
,, 2. Lateral view of *Rhynchobdella dhanashorii*, sp. nov.
,, 3. Lateral view of *Mastacembelus manipurensis*, sp. nov.
,, 4. Upper view of head of *Nemachilus sikmaiensis*, sp., nov., × $2\frac{2}{5}$.

Lepidocephalichthys irrorata, sp. nov.

FIG. 5. Lateral view of type-specimen, × $1\frac{3}{5}$.
,, 5*a*. Under surface of head of same, × $2\frac{2}{5}$.
,, 5*b*. Upper surface of head of same, × $2\frac{2}{5}$.

Psilorhynchus sp., Hora.

FIG. 6. Lateral view of immature specimen, × $3\frac{1}{5}$.
,, 6*a*. Under surface of head of same, × $4\frac{4}{5}$.



FISH FROM MANIPUR.

S. C. Mondul & A. C. Chowdhary del.

EXPLANATION OF PLATE X.

Nemachilus from Manipur.

Nemachilus sikmaiensis, sp. nov.

FIG. 1. Lateral view of type-specimen, × 2.
,, 1*a*. Under surface of head of same, × 3.

Nemachilus prashadi, sp. nov.

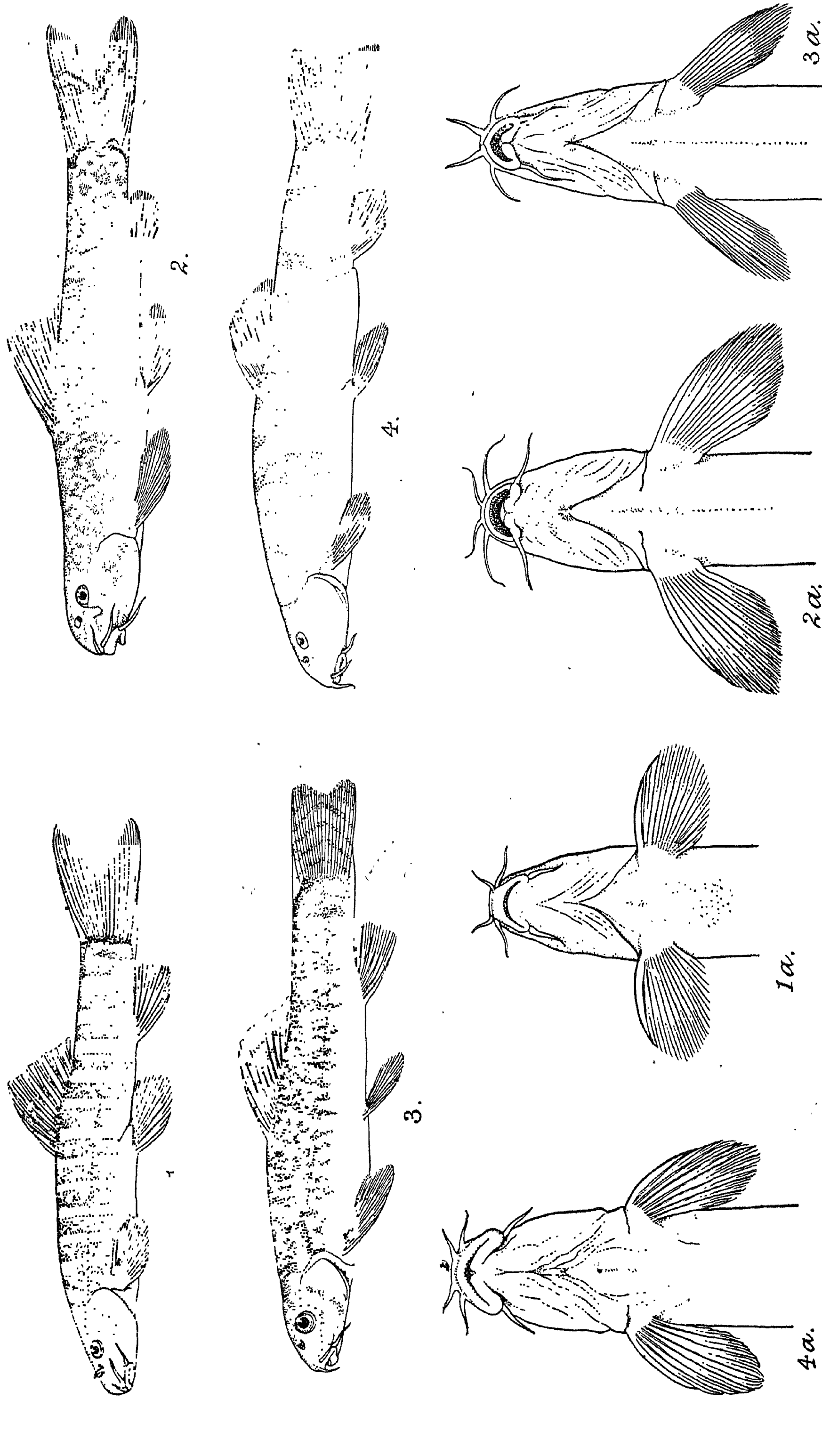
FIG. 2. Lateral view of male specimen, × 1½.
,, 2*a*. Under surface of head of same, × 3.

Nemachilus zonalternans (Blyth).

FIG. 3. Lateral view of a female specimen, × 2.
,, 3*a*. Under surface of head of same, × 3.

Nemachilus kangjupkhulensis, sp. nov.

FIG. 4. Lateral view of type-specimen, × 2.
,, 4*a*. Under surface of head of same, × 3.



NEMACHILUS FROM MANIPUR.

A. C. Chowdhary del.

EXPLANATION OF PLATE XI.

Manipuri fishing nets and baskets.

FIG. 1. Shows a girl manipulating *ilb-jung-thauri,* the characteristic Manipuri net. A boy is seen using a crude type of fishing rod.

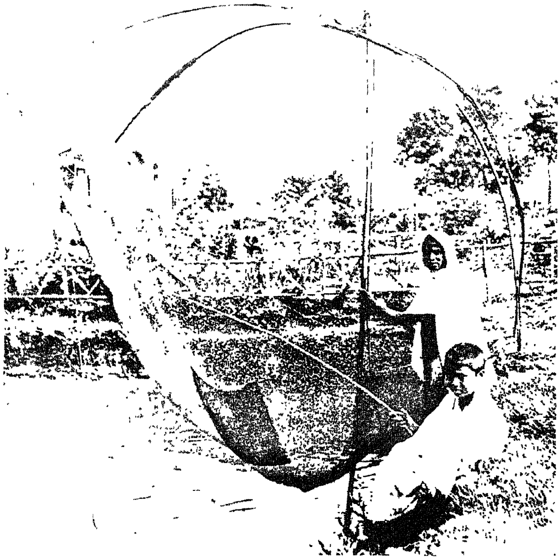
,, 2. Dam constructed by Manipuris in small streams for capturing fish that come to the surface. Notice especially the arrangement of *chora-ruh* and *lusak*.

,, 3. A type of basket, *ishto-machai*, used for scooping out water.

,, 4. *Lungtharai-machai*, a kind of net extensively used for capturing small fish in the Loktak Lake.

,, 5. *Chigailong-machai*, a fish-basket with a handle.

,, 6. *Lóng*, or the bowl-shaped fish basket.



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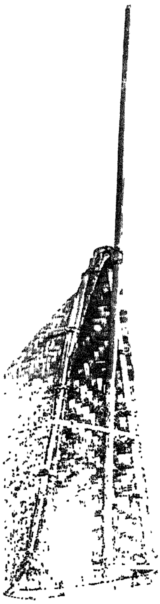

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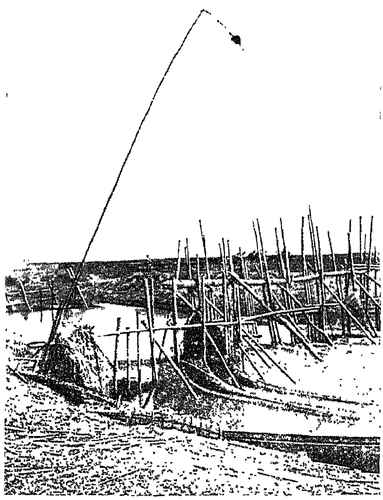

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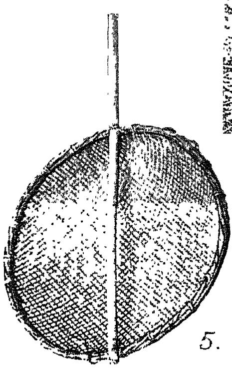

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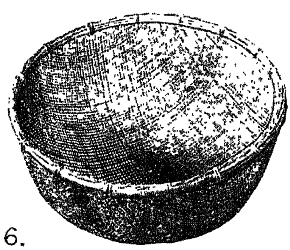


6.

S. C. Mondul Photo.

EXPLANATION OF PLATE XII.

Photographs of Manipur fish-traps.

FIG. 1. Photograph of a model of *kao*.

,, 2. Photograph of an original Manipuri *lo-lu*.

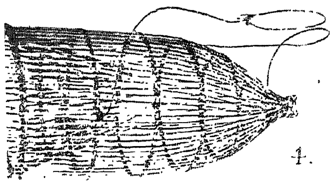
,, 3. Photograph of an original Naga *lo-lu*.

,, 4. Photograph of a model of *tikhau-ruh*.

,, 5. Photograph of a model of *chora-ruh* and *lusak*, the latter telescoping into the former.

,, 6. Photograph from an original *kalio-ruh*, etc. *Kalio-ruh* is shown in the centre, covered by *chikap*. Two double bamboo pegs at the sides are *au-ung*.

,, 7. Photograph of a model showing the arrangement of *kalio-ruh*, *chikap* and *au-ung* when used for capturing bottom fish.



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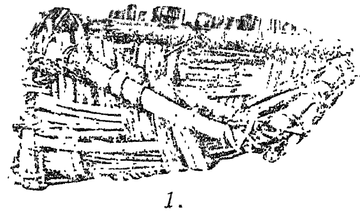

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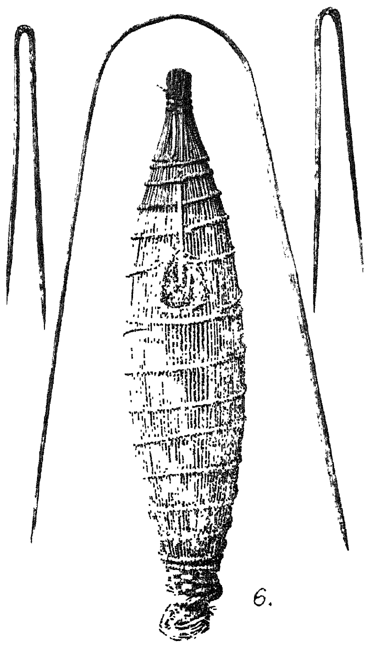

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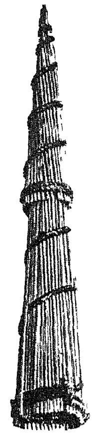

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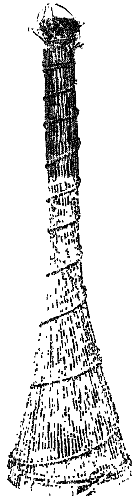

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S. C. Mondul Photo.

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XIX, 1923. No. 4.

13. On Certain Local Names of the Fishes of the Genus *Garra*.

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(Read at the Eleventh Annual Meeting of the Indian Science Congress and communicated with the permission of the Director, Zoological Survey of India.)

The fishes of the genus *Garra* (=*Discognathus*) are characterized by the possession of a more or less well-developed suctorial disc on the under surface of the head slightly behind the mouth. Most of the species of the genus,[1] which are numerous in the hilly districts of India and Burma, inhabit rapid-running water and protect themselves against swift currents by clinging to rocks and stones by means of their suctorial disc. This habit of the fish, its form and the morphological structure of the disc are the chief factors which are referred to in the local names of the species in various parts of India and Burma. In some species one or more proboscides are developed on the snout, and in some of the vernacular names a reference is made to this character.

In Northern India (the Punjab and the United Provinces) *pathar-chat* is the common name under which these fishes are known. Literally it means "stone-lickers" and obviously refers to the fish's peculiar mode of feeding, for it scrapes minute algae, etc., from the rocks and stone with the help of its sharp jaws. These food particles are prevented from escaping by loose folds of skin forming the false upper and the lower lips and are swallowed as they are set free. The fish as it feeds moves up the substratum, thrusting itself forwards by hardly perceptible movements of its tail, but at the same time clinging firmly to the substratum by means of its suctorial disc. Other fishes of similar habits such as the species of the genus *Glyptothorax* are also called *pathar-chat*.

There are two vernacular names of historic importance, *lamta* and *godyari*. At the beginning of the nineteenth century Buchanan found these names current in the Gorakhpur and Bhagalpur districts respectively. He evidently believed that the two names referred to the same species, for he says in his list of the fishes of the Gorakhpur district: "The Godyari of the Bhagalpur list is here called Lamta."[2] Moreover, he labelled

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[1] Hora, *Rec. Ind. Mus.*, XXII, pp. 633–687, plates, xxiv—xxvi (19[illegible]).

[2] Day's volume on the Fisheries and Botany of Bengal in Hunter's *Statistical Account of Bengal*, p. 103 (1877).

an illustration of a species with the disc-character well-marked as *Cyprinus godyari* and in *An account of the Fishes of the Ganges* has described it as *Cyprinus lamta*. The illustration occurs among the manuscript drawings of this author, now preserved in the library of the Asiatic Society of Bengal. While gathering information for determining the specific limits of Buchanan's *lamta*, I undertook a tour to the exact localities whence Buchanan obtained his specimens of *godyari* and *lamta*. I was surprised to find, however, that neither of these names was familiar to the local fishermen. The name *lamta* or any similar name was quite unknown in the town of Gorakhpur and its vicinity, and inquiries even from the older fishermen elicited no information about it. Nor did they recognise as local fish some specimens of *Garra* which I had taken with me. In the hills south of Monghir (the Kharagpur Hills) whence Buchanan obtained his specimens of *godyari*, the fish was known under two names, *gudar* and *pathar-chat*. *Gudar* seems to be connected with *godyari*; in it reference is made to the subcylindrical form of the fish, for *gudar* means a cylindrical object in the local dialect. In the Kumaon Hills all the species of the genus *Nemachilus*, which possess more or less the same form of body, are called *gudar*.

In the Manipur Valley (Assam) a small species (*G. rupiculus*) is found in rapid-running water among pebbles and stones and is called *nug-nga* or "the stone-fish," while the larger species (*G. nasutus*) which in often found in the sluggish streams of the valley is called *nga-mu-sangum*. *Ophiocephalus* is known in Manipuri as *nga-mu* or "the black-fish." According to some Manipuris *G. nasutus* is like an *Ophiocephalus* but possesses a *sangum*, i.e. "an umbrella" or "a mushroom." This refers to the mental disc. According to others, however, *sangum* is an insect which lives in grass and by its bite produces a swelling—again a reference to the disc which is supposed to resemble the swelling. It is not the Manipuris alone who associate species of *Garra* with those of *Ophiocephalus*, for in Canarese also, according to Day[1] *Garra* is known as *Pandi-pakke*, "the stone Ophiocephalus."

I am indebted to Dr. B. Sundara Raj, Director of the Madras Fisheries, for the following information: "The fishes of the genus *Garra* (*Discognathus*) are known by the following names in this Presidency. Tamil '*Kal Koruvai*,' title from clinging to rocks, *Kal* (Tamil) = stone + *Kuravai* (Tamil) = shortness. In the Coimbatore District, it is called in Tamil '*Nai Kaha*' or '*Kul Kaha*'; the etymological meaning of the words '*Nai*' and '*Kaha*' is not known; *Kul* means in Tamil stone. Dr. Day's Canarese name of the fish consists of two well-known Canarese words '*Pandi*' and '*Pakke*' meaning, pig and fish

[1] Day, *Fish-India*, p. 528 (1878).

respectively. In the South Kanara District it goes by the name '*Kal mura*' (*Kal* means 'stone' and *mura* probably 'fish') i.e. stone fish; in Tulu also it is called *Kal mura*.' In the name *Pandi Pakke* probably reference is made to the proboscis on the snout which looks very much like the snout of a pig.

According to Mr. C. R. Narayan Rao, to whom I am obliged for the information, "*Garra* is known in Mysore to the fishermen as "*Rathi Koraka* (Telugu), "*Kal Meenu*" (Kannada, i.e. Canarese) and in Coorg "*Handi Kurlu*" (Canarese).

Rathi = *Kāl* = stone.
Koraka = sucker.
Meenu = fish or Carp.
Handi = pig.
Kurlu = corrupt."

For the name *Korafi-Koali* mentioned by Day as current in Mysore Mr. Rao gives the following explanation: "*Koravai* = *Koravan* = thief; from the habit of the fish slowly approaching the surface and then suddenly darting to catch air—then as suddenly disappearing below." This name is also applied to *Ophiocephalus punctatus*. *Koali* (Tamil)—corruption of *Kolai*—referring to the inedible nature of the eggs of the fish. *Koali* is the name of *Rasbora daniconius* also."

In the Khasi Hills the species of *Garra* are known under three appropriate names, viz. *Sherdong*, *Usher-keu* and *Udoh-arkhmut*. In the first two names a reference is made to the habit of the fish, while the third means "double-nosed fish" in reference to the proboscides present on the snout of adult specimens of *Garra gotyla*. *Sherdong*, which means a fish that circles round (*Sher* = fish, *dong* = to circle round), refers to the habit of these fishes, which go round and round a fisherman when he tries to catch them. In floods the fish are said to climb up rocks in rapid water in shoals, and hence the Khasi name *Usher-keu*, for *keu* means "to climb up" and *usher*, a fish.

The Inthas of the Southern Shan States (Burma) living in the neighbourhood of the Inlé Lake know *Garra* as the "post-climbing fish" (*nga taing-tet*). To understand the significance of this name, which is applied to *Garra gravelyi*, it is necessary to realize that houses are often built by the Intha on posts standing in water as much as ten or twelve feet deep. Dr. Annandale[1] describing the habit of *G. gravelyi* in the Inlé Lake, says: "We lived for some time in a house of the kind more than a mile from shore in the Inlé Lake, and it was possible to watch the ascent of the house posts by the fish, which was

[1] Annandale, *Rec. Ind. Mus.*, XIV, p. 45 (1918); for other details about Inlé Lake see Annandale, *Bombay Journ. Nat. Hist. Soc.*, XXVIII, pp. 1038–1044, 3 pls. (1922).

usually seen in the first instance swimming out from a thicket of weeds. It then settled with its head pointing upwards, low down on one of the house-posts and began to move up it slowly, browsing as it did so on the small algae and polyzyoa (*Hislopia lacustris*) with which the posts were covered. The sucker-like structure of the lips enabled it to retain a fairly tight hold on the post while it remained still: its ascent was effected by gentle almost imperceptible movements of the tail.''

At He-Ho, a few miles from the Inlé Lake, where there are no posts for the fish to climb, this same species is known as ''stone-climbing fish.'' *nga kayauk-tet*

In the Darjiling Himalayas[1] there are two species of *Garra*, *G. gotyla* and *G. annandalei*. The former possesses proboscides on the snout, while in the latter this region is smooth. On this morphological difference the two species are distinguished from each other by the local fishermen and probably it is to this character that a reference is made in the local names of species.

List of Vernacular names of the Fish of the genus Garra.

Locality.	Local Name.	Meaning of Local Name.
N. W. Provinces; certain districts of the Punjab and the United Provinces.	*Pathar-chat* ..	*Pathar* = stone; *chat* = to lick. Stone-licking fish.
Punjab	*Dhoguru* * ..	..
,,	*Koorka* * [2] ..	..
Gorakhpur (U.P.) ..	*Lamta*	..
Monghir (Behar) ..	*Godyari*	..
,,	*Gudar*	Cylindrical fish.
Bengal	*Choak-si* * [3] ..	..
Darjiling Himalayas	*Budena* ..	Probably refers to the proboscis on the snout.
,,	*Luheri*	..
Khasi Hills (Assam)	*Udoh-arkhmut* ..	Double-nosed fish
,,	*Sher-dong* ..	Fish that circles round and round a fisherman.
,,	*Usher-keu* ..	*Ushser* = fish; *Keu* = to climb, rock-climbing fish.

[1] I am indebted to Mr. G. E. Shaw for the following information:— In the Darjiling Himalayas *Garra gotyla* is called *Budena* and *G. annandalei* is named *Luheri*. '' But no one here seems to know what the names mean or why they are so called.''

[2] Mr. Donald of the Punjab Fisheries has informed me that fishermen of the Kangra District '' can give no reason for, or meaning of the word *Kurka* as applied to *Discognathus lamta*.'' (*G. gotyla* is found in the Kangra valley.)

[3] I have not been able to find any suitable explanation for *Choak-si* This name is not known to most of the Bengalis living in Calcutta, nor have I been able to find its meaning.

* The local names marked with an asterisk (*) are taken from Day.

Locality.	Local Name.	Meaning of Local Name.
Manipur (Assam) ..	*Nug-nga* ..	*Nug*=stone; *nga*=fish. Stone-fish
,,	*Nga-mu-sangum* ..	*Nga*=fish; *mu*=black; *sangum*=umbrella or mushroom, or refers to an insect. Black fish with an umbrella or swelling on the chin.
Inlé Lake, S.S. States (Burma).	*Nga taing-tet* ..	*Nga*=fish; *taing*=house-post; *tet*=to climb. House posts climbing fish
He-Ho, S.S. States (Burma).	*Nga kayauk-tet* ..	*Kayauk*=stones. Stone climbing fish.
" Canarese " ..	*Pandi-pakke* * ..	" Stone ophiocephalus " pig fish.
" Tamil " ..	*Kul-korava* * ..	*Kul*=stone. Probably means stone fish.
Coimbatore District..	*Nai-kaha* ..	..
(Tamil)	*Kul-kaha* ..	Stone fish.
South Kanara District	*Kal-mura* ..	Stone fish.
Tulu	,,	
Mysore	*Rathi-koraka* (Telegu)	*Rathi* = stone; *koraka* = sucker. Stone suckers.
,,	*Kal-meenu* (Canarese)	*Kal*=stone; *meenu*=fish. Stone fish.
	Korafi-koali * ..	A thief fish with inedible roe.
Coorg	*Handi-kurlu* ..	*Handi*=pig; *kurlu*=corrupt. Corrupt pig fish.

* The local names marked with an asterisk (*) are taken from Day.

Issued July 28th, 1924

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XIX, 1923, No. 4.

12. Fish Recent and Fossil.

A Review of Some Recent American Work.

A Bibliography of Fishes. By Bashford Dean and others. Three volumes (Vol. I, pp. 1–718, by Dean and Eastman, 1916; Vol. II, pp. 1–702, by Dean and Eastman, 1917; Vol. III, pp. 1–707, by Dean, Gudger and Henn: New York) published by the American Museum of Natural History in the "Science Education Series."

The Genera of Fishes. By David Starr Jordan. Four parts (pt. I. pp 1–161, by Jordan and Evermann, 1917; pt. II, pp. 163–284, 1919: pt. III, pp. 285–410, 1919; pt. IV, pp. 415–576, 1920 by Jordan: California) published by Leland Stanford Junior University, California in the "University Series"

A Classification of Fishes including Families and Genera as far as known. By David Starr Jordan. Stanford University Publications. "University Series." *Biological Sciences*, III, No. 2, pp. 79–243 (1923).

Zoologists at the present day are almost in the position of the blind workers engaged in building a termite mound. Each constructs his little pellet of information and places it somewhere, without exactly knowing its relation to other pellets but with a subconscious feeling that he is doing the right thing, and possibly even with a vague instinct that his work is helping on some great enterprise. The wealth of material is boundless, the number of workers almost innumerable, and no one worker knows what his neighbour is doing. To raise us from this somewhat hopeless intellectual limbo we need physicians and teachers who will open our eyes and instruct us what to see. For the training of the physician and teacher patience is necessary. He must study not only Nature as she exists but Nature as she appears through the countless facets of the eyes of Scarabee. To drop all metaphor, we need men (or women) who are willing and able to abstract and codify existing information.

In this respect ichthyologists are now perhaps happier than the students of any other group of animals, thanks to the devoted labours of two little bands of enthusiastic students of the fishes, both American but working on different sides of the continent In New York we have Professor Bashford Dean and his able coadjutors, while in California Professor David Starr Jordan has trained a whole school of young zoologists to assist him in his almost equally useful work.

The object of this review is not to abstract abstracts already sufficiently concise, but rather to call attention to these bibliographical monographs which are of almost unique importance. All contain, as is inevitable, errors of detail, but their breadth of outlook is beyond cavil and their general accuracy of a very high order.

Fish, as we all know, are the most ancient vertebrates of which unmistakable remains have been preserved and even the most highly developed members of the class have retained many primitive characters, probably because they have never deserted their original medium. A few highly specialized species are able to breathe air for a time, a few can hop about on land, a few can even glide through the air, but no species has become completely or even habitually terrestial or aerial, all are aquatic, having their habitation and reproducing their kind in water. The great majority, moreover, still retain what was probably their ancestral home in the sea.

Professor Jordan in his "*Classification of Fishes*" (1923) mentions all the generic names which have so far been used in both the true fishes, the lampreys and the amphioxi, while in his "*Genera of Fishes*" (1917–1920) he gives the original references to the generic names and notes the genotype of each. Further he discusses the validity of certain of the genera in a general way. In the former work he recognises no less than 638 families in the three groups. Emphasizing his point of view that "analysis must precede synthesis," he has thought it " better to lay a certain stress on abberrant forms than to include them uncritically in expanded groups, the definition of which is impaired or denied by their presence." Seeing that all the fish genera since 1758 have been discussed, the vast scope of his investigations and the great debt we owe him are clear without further comment, but the fact that he deals with fossil as well as recent genera should not be allowed to escape notice.

Professor Jordan's work, however, is primarily for the specialist and has only an indirect interest for the philosophical naturalist, the fishery expert or the pisciculturist. Professor Bashford Dean and his coadjutors have approached the subject from a still wider, if more strictly bibliographical point of view. In two volumes, each of a little over 100 pages, they have given a list of the papers on recent and fossil fish published from 1758 to 1914, including over forty thousand titles. This list is arranged under the names of the authors, but in their third volume, which is of about equal length, they have compiled a singularly complete and admirably arranged subject index to all that has been written on fish and fisheries since the time of Linnaeus, with an author's catalogue of pre-linnaean works in which such as those of Aristotle and, more surprising, of Ovid are not omitted. Other subjects discussed in the volume are periodicals relating to fish and fish-culture, voyages and expeditions on which fish were studied, institutions connected with fish-culture and text-books in which particular attention is paid to fish.

All this, is it easy to believe, is the result of 30 years' work. If only the matter can be kept up to date by a supple-

ment issued, say once in ten years, the gratitude of all interested in fish and fisheries to Professor Bashford Dean and to the American National Museum, which has published the three volumes, will be perpetual. No ichthyologist, palaeontologist, pisciculturist or fishery expert can afford to be without these three volumes which should be supplemented for all those undertaking ichthyological research by those of Professor David Starr Jordan. This is particularly true of India, in several of the colleges of which research on the anatomy of fishes is being undertaken with Day's volumes in the "*Fauna of British India*" and the same author's "*Fishes of India*" as sole works of reference. Invaluable as these monographs of Day were in their time, and indispensable as they still remain, they have, as is only natural, been superseded in many respects, by more recent investigations, and to trust to them alone is to court disaster.

N. ANNANDALE,
S. L. HORA.

Issued July 25th, 1924.

Sewell, R. B. S. (1925)

" The Adhesive Apparatus Of The " Sucking-Fi

Nature, CXV, pp.48-49, Jan. 10.

THE ADHESIVE APPARATUS OF THE " SUCKING-FISH ".

In order to test the action and the mechanism of the disc in Echeneis and determine whether or not one function of the disc is to act as a sucker (in the strict sense of the word) a series of experiments were carried out.

Specimens were allowed to attach themselves to clean sheets of glass, and the disc was then examined and compared with the surface of the disc when unattached. In the unattached state the rim of the disc is soft and flexible, and around the anterior half of the disc the margin is distinctly raised while the posterior half is flat; the transverse ridges, on which are numerous posteriorly-directed spines, lie flat against each other and present a practically continuous surface. When the animal has attached itself by the disc, the smooth flexible margin can be seen to be closely pressed against the glass. The ridges running transversely are now separated from each other by narrow spaces, the two series, i.e. right and left, being separated by a median soft band that passes backwards in the middle line. At the

posterior end this ridge stops short, so that the terminal posterior part of the sucker is occupied by a single large cavity the floor of which is depressed. Air bubbles can be seen between the ridges and in this posterior chamber, and such bubbles may be seen passing along each side of the median partition into the posterior chamber.

When thus attached, if the posterior rim of the sucker is separated from the glass, air immediately enters the posterior chamber, and by slowly pulling the sucker away, each pair of spaces between the transverse ridges can be opened separatedly, each giving way with a slight sucking noise; each compartment of the disc thus appears to act as a separate sucker.

When once the fish has attached itself by the disc it can be moved forwards or sideways easily, the disc sliding over the plate, but on attempting to pull the fish backwards , the spines on the rudges of the disc come into action and tend to prevent any backward movement; and if the disc is forcibly pulled backwards the spines can be heard scraping over the surface. If pieces of twine are placed across the disc they prevent the formation of

the necessary partial vacuum and the disc fails to adhere, whlie if the disc is adherent, the introduction of a finger-nail or the blade of a knife between the disc and the surface to which it is adhereing allows air to enter and the hold of the sucker is immediately destroyed.

Further experiments were conducted in order to try to determine the strength of adherance of the sucker. In the first experiment, an *Echeneis* was allowed to attach itself to the enamel surface of a dish and the hook attached to a spring balance was passed through the gill from one side to the other. By standing on the dish and pulling on the spring balance, the amount of force could be fairly accurately measured, and in the specimen experimented with the fish withstood a vertical pull of more than thirty pounds before the hook tore through the tissues of the body. Further experiments were conducted by allowing the fish to attach itself to an enamel iron tray, the tray being fastened securely by rope to the spring balance. The balance was attached to a stanchion, and the head of the fish was seized in a towel to prevent the fingers from slipping on the skin of the fish. Two examples withstood a vertical pull

of 34 and 35 lb. respectively before the sucker was pulled away from the surface.

It seems to me that there is little doubt that the disc acts as a true sucker by the creation of a partial vacuum, while the spines are of use in preventing this sucker from sliding on the surface of attachment. Thus, during life, when the _Echeneis_ attaches itself to some other larger fish, it is owing to the partial vacuum formed that the disc adheres to the surface, while the spines prevent the _Echeneis_ from being swept backwards by thr rush as the large fish makes its way through the water.

A further point worth noting is that when the sucker is in action and the _Echeneis_ is attached to any object, all movement of the fish, except that of the mouth and the gills that is necessary for respiration, seems to be suspended and inhibited. The fish hangs absolutely motionless, and in the case of a fish that had been well hooked, it was found that by allowing the fish to attach itself to a glass plate it would hang motionless, while the hook and a great part of the fishes jaw was cut out! It appears that the action of the sucker causes inhibition of all movement of the body and tail.

In order to avoid any misapprehension, may I be allowed to add that my experiments were carried out at the suggestion of Dr. Hora, and the above notes, recording the results, were forwarded to him last January.

R. B. Seymour Sewell.

R.I.M.S."Investigator "

(Nature, CXV, pp. 48-49, Jan. 10, 1925)

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXII, 1926, No. 3.

ARTICLE NO. 18.

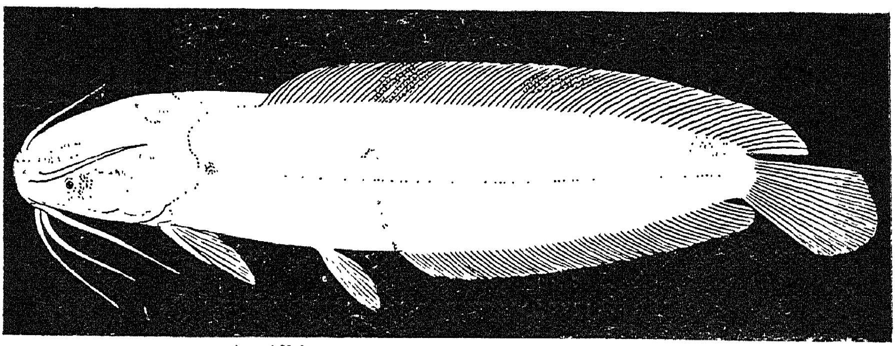
An Albino Magur, *Clarias batrachus* (Linn.).

By SUNDER LAL HORA, D.Sc., F.L.S., F.Z.S., *Officiating Superintendent, Zoological Survey of India.*

(Published with the permission of the Director, Zoological Survey of India.)

Dr. Satya Churn Law has very kindly presented to the Zoological Survey of India an albino specimen of the common Bengal *Magur*, *Clarias batrachus* (Linn.) preserved in spirit. The specimen was collected, along with another albino specimen and a number of examples showing normal colouration, in a pond at Midnapur. I am greatly indebted to Dr. Law for giving me an opportunity of examining the specimen and making a few observations on it.

The abnormal fish is white with the exception of two small patches of lead colour on the dorsal fin and a few dots and



An Albino Magur, *Clarias batrachus* (Linn.).

patches of lighter colour on the body and its appendages. The upper surface of the pectoral fin of the right side is infuscated with gray in its proximal two-thirds. A small black spot is present on the upper surface of the snout and a spot is also present on the left nasal barbel. On the left side the following colour markings are present:—a small patch of gray colour behind the eye; a small rounded patch behind the gill cover; an oval patch dorsal to the lateral line and in position slightly behind the ventral fin; an oblique patch extending from below the lateral line to the commencement of the anal fin and a patch below the dorsal fin near its termination. On the right side

there is only one patch of lighter colour immediately below the commencement of the dorsal fin.

Dr. B. L. Chaudhury has very kindly informed me of an interesting case that came under his notice of partial albinism in the climbing perch of Bengal, *Anabas testudineus* (Bloch.) The fish had a white patch $1\frac{1}{2}'' \times 1''$ on the right side over the abdominal region. The extent of the white patch was observed to vary with the season of the year.

Several instances of albinism have been recorded in fishes,[1] but in individual instances such as those recorded above it is not possible to say definitely whether such a condition is the result of a congenital variation (mutation) or is due purely to pathological conditions.

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[1] For works dealing with this subject see Dean's *Bibliography of Fishes* III, p. 393 (New York: 1923); also Archey, *N. Zealand Journ. Sci. Tech. Wellington* VI, p. 342 (1924).

Issued September 28th, 1927.

Author's Copy.

RECORDS

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Vol. XXVIII, Part IV, pp. 221—223.

On a new species of the genus *Ctenotrypauchen* Steindachner.

By

SUNDER LAL HORA.

CALCUTTA:

DECEMBER, 1926.

ON A NEW SPECIES OF THE GENUS *CTENOTRYPAUCHEN* STEINDACHNER.

By SUNDER LAL HORA, *D.Sc., Officiating Superintendent, Zoological Survey of India.*

Dr. K. H. Barnard, Assistant Director of the South African Museum, has very kindly sent to me five examples of an interesting species of the genus *Ctenotrypauchen* for determination. In a recent revision of the eel-like Gobioid fishes I[1] established the validity of Steindachner's genus and pointed out the importance among these fishes of the form of the ventrals for taxonomic purposes. I had then no specimen of this genus before me and in distinguishing it from *Trypauchen*, *Amblyotrypauchen* and *Trypauchenichthys* had merely relied on the published descriptions and figures of the species referable to *Ctenotrypauchen*. The present material, on which I am basing the description of a new species, has helped me greatly in understanding precisely the generic limits of the various genera of the sub-family Trypaucheninae.

In external appearance the fishes of this sub-family are very much alike and it is only on the form of the ventrals and the presence or absence of canines that they can be separated into distinct genera. In *Ctenotrypauchen* canines are absent and the ventrals form a disc, which is distinctly notched posteriorly. In this respect *Ctenotrypauchen* is intermediate between *Trypauchen* Cuv. and Val. and *Trypauchenichthys* Bleeker.

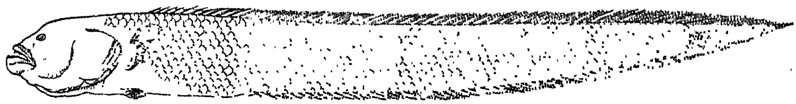
The species described below is the fourth species of the genus *Ctenotrypauchen* known so far, the other three being *C. microcephalus*[2] from "Sungi-duri, in aquis fluviomarinis" (Borneo), *C. wakae*[3] from "Inland sea of Japan in sandy bays" and *C. chinensis*[4] from China. The new species is from the Natal coasts. This apparently discontinuous distribution of the genus is probably due to the fact that these fishes live in mud and are liable to be overlooked by collectors. It is probably on this account that forms from the intermediate regions have not hitherto been brought to light. It is rather unfortunate that we do not know the exact locality whence *C. chinensis* was obtained in China.

Ctenotrypauchen barnardi, sp. nov.

It is a long and slender species, greatly compressed from side to side and gradually tapering posteriorly. The head is broadly pointed posteriorly and its length is contained 5·5 to 5·8 times in the total length without the caudal; it is as deep as the body and its height at the occiput is contained 1·4 times and the greatest width 1·6 times in its length. The height of the body is contained 7·2 to 9·2 times in the total length

[1] Hora, *Rec. Ind. Mus.* XXVI, pp. 155-164 (1924).
[2] Bleeker, *Acta. Soc. Sci. Indo-Neerl.* VIII, p. 62 (1860).
[3] Jordan and Snyder, *Proc. U. S. Nat. Mus.* XXIV, p. 127 (1902).
[4] Steindachner, *Sitzb. Acad. Wiss. Wien.* LV, p. 530 (1867).

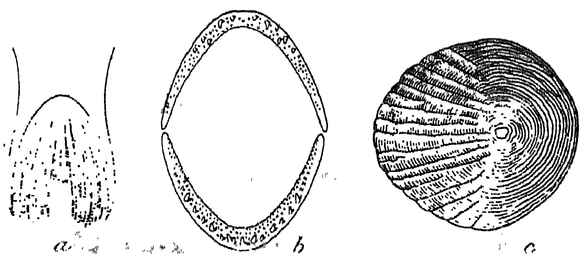
without the caudal. The eyes are minute and thickly covered with skin, they are placed at the dorso-lateral borders of the orbital depressions. The interorbital space is flattened and is somewhat convex. The snout is slightly shorter than one-third the length of the head. The deep pits at the upper edge of opercle are well marked. The gill-openings are restricted to the sides and do not extend forwards; the isthmus is fairly



TEXT-FIG. 1.—Lateral view of *Ctenotrypauchen barnardi*, sp. nov., × 13/16.

broad. The mouth extends to just below the anterior end of the orbital depression, the lower jaw is slightly longer than the upper. The mouth is obliquely directed upwards. The teeth are simple and are arranged in two rows, those of the outer row being somewhat enlarged; there are no canines. There is a sharp, bony crest along the mid-dorsal longitudinal axis of the head posterior to the eyes. There is a similar nuchal crest, the ridge being posteriorly continued into the dorsal fin. There are four branchiostegal rays and the gill-rankers are represented by mere elevations on the arches. The anterior nostrils are provided with distinct tubes and the barbels are totally absent.

There are no scales on the head, but the skin is provided with many mucous pores. The body is covered with rounded, cycloid scales, but the area from nape to front of dorsal and the whole of the belly are naked. On the sides the scales extend right up to the bases of the pectorals and the gill-openings. There are about 65 to 67 series of scales along the lateral line and about 12 series of scales between the bases of the dorsal and the anal fins.



TEXT-FIG. 2.—Scale, jaws and ventral fins of *Ctenotrypauchen barnardi*, sp. nov. *a*. Ventral fins × $4\frac{1}{2}$; *b*. Jaws × $3\frac{3}{4}$; *c*. Dorsal scale from about the middle of the fish × $15\frac{3}{4}$.

A scale from the middle of the body is more or less ovoid in general outline; it is somewhat broader than long. The nucleus is situated in the centre of the scale and there are a number of fine circular striae all round it. The anterior half of the scale is provided with about 16 radii to the periphery from the nucleus. The whole of the scale is covered with a membrane of the skin.

The dorsals are connected together, there being six spines and from 49 to 51 rays. The anal is similar to the dorsal and contains one spine and 44 to 47 rays. The dorsals commence about three scales behind the base of the pectoral. Both the dorsal and the anal fins are connected with the caudal, which is greatly elongated and is acutely pointed behind. The caudal fin is longer than the head and contains 17 rays. The upper half of the pectoral is much more developed than the lower, the fin is, as a whole, directed upwards and backwards and is greatly elongated; its length is contained 2 to 2·6 times in the length of the head. The ventrals are small and are united to form a disc which is deeply notched posteriorly; their length is contained from 3 to 4 times in the length of the head.

The colour in spirit is uniformly brownish, speckled with dull white in the region of the body and the tail.

Locality.—Coasts of Natal, South Africa. Dr. Barnard informs me that he has collected one specimen of this species in the Delagoa Bay.

Type-specimen.—The type-specimen and one co-type are preserved in the South African Museum, Cape Town; while the remaining three co-types are in the collection of the Zoological Survey of India.

Relationships.—*Ctenotrypauchen barnardi* is distinguished from *C. microcephalus* in possessing a larger head and in having five rays besides a spine in the pelvic fin; from *C. wakae* in proportions and lepidosis and from *C. chinensis* in the form of the pectorals and in possessing more scales along the lateral line. The new species is closely allied to *C. microcephalus* in lepidosis and in the number of fin rays, while the Japanese and the Chinese species show close resemblance in possessing fewer rows of scales along the lateral line.

Measurements in millimetres

Total length excluding cauda	101·0	98·0	87·0	65·[illegible]
Length of head . .	17·2	17·0	15·7	11·2
Height of head . .	12·3	11·8	10·6	8·0
Width of head . .	10·6	10·5	9·7	6·8
Height of body . .	13·0	10·5	12·0	8·0
Length of pectoral . .	8·0	7·0	7·5	4·2
Length of ventral . .	5·0	[illegible]	[illegible]	[illegible]

Norman, J. R.

1926. - A new Blind Catfish from Trinidad, with a List of the Blind Cave-fishes.

Ann. Mag. Nat. Hist. ser.9, XVIII, pp.324-330.

From the ANNALS AND MAGAZINE OF NATURAL HISTORY,
Ser. 9, vol. xviii. p. 324, *October* 1926.

A new Blind Catfish from Trinidad, with a List of the Blind Cave-fishes. By J. R. NORMAN.

(Published by permission of the Trustees of the British Museum.)

IN July 1924 the British Museum (Natural History) received from Mr. F. W. Urich, of the Department of Agriculture, Trinidad, a specimen of a blind catfish from the Guacharo Cave. As this fish had not been previously recognized, I

asked Mr. Urich whether he could obtain further specimens, and he has recently been kind enough to send two more well-preserved examples from the same locality.

CÆCORHAMDIA, gen. nov.

Similar to *Rhamdia*, but without eyes.

Cæcorhamdia urichi, sp. n. (Fig. 1.)

Depth of body about 5 in the length, length of head $4\frac{1}{5}$ to $4\frac{1}{4}$. Head covered with skin, nearly as broad as long. No trace of eyes externally ; the skin above each orbit is invaginated to a varying degree, forming a small pit *. Jaws equal anteriorly or upper a little projecting ; maxillary barbel extending to anterior part or middle of adipose fin ; outer mandibulary barbel reaching end of pectoral or not quite as far. Occipital process long, narrow, not reaching the basal shield of the dorsal spine. Dorsal I 6–7 ; spine slender ; middle branched rays about $\frac{3}{4}$ the length of head ; free edge of fin convex. Adipose fin commencing a short distance behind the dorsal, separated from base of caudal by a distance which is 4 to $4\frac{1}{3}$ in its length ; length $2\frac{1}{2}$ to nearly 3 times in that of fish. Anal 11 ; low anteriorly, rounded or obtusely pointed posteriorly, the rays gradually increasing in length to the seventh or eighth, which is rather more than $\frac{1}{2}$ the length of head. Caudal forked ; the upper lobe pointed and a little shorter than the rounded lower lobe. Pectoral spine with inner edge serrated in its basal half, about $\frac{3}{4}$ as long as the fin, which is $\frac{3}{4}$ to $\frac{4}{5}$ the length of head. Pelvics extending $\frac{4}{5}$ or $\frac{5}{6}$ of the distance from their base to the origin of anal. Uniform pale yellowish brown ; an indistinct white band across basal part of dorsal fin.

Two specimens, 125 to 140 mm. in total length, from a pool in the interior of the Guacharo Cave, Trinidad. Mr. Urich informs me that this pool is always in complete darkness ; very occasionally, in times of heavy rains, the pool becomes connected with a rivulet running out of the cave.

Apart from the absence of eyes, this fish appears to be almost identical with *Rhamdia queleni*, Quoy and Gaimard †

* The fish has the appearance of having had the eyes gouged out and a part of the original sockets retained. *Typhlobagrus kronei*, another blind Pimelodine catfish presents a similar appearance (Eigenmann, Mem. Carnegie Mus. vii. 1917, p. 255).

† *Rhamdia wilsoni*, Gill, from Trinidad, may be synonymous with this species.

(fig. 2), a variable species which is widely distributed in eastern South America north of the Rio Plata. When specimens of equal size are compared, however, the mandibulary barbels appear to be somewhat longer in the blind fish.

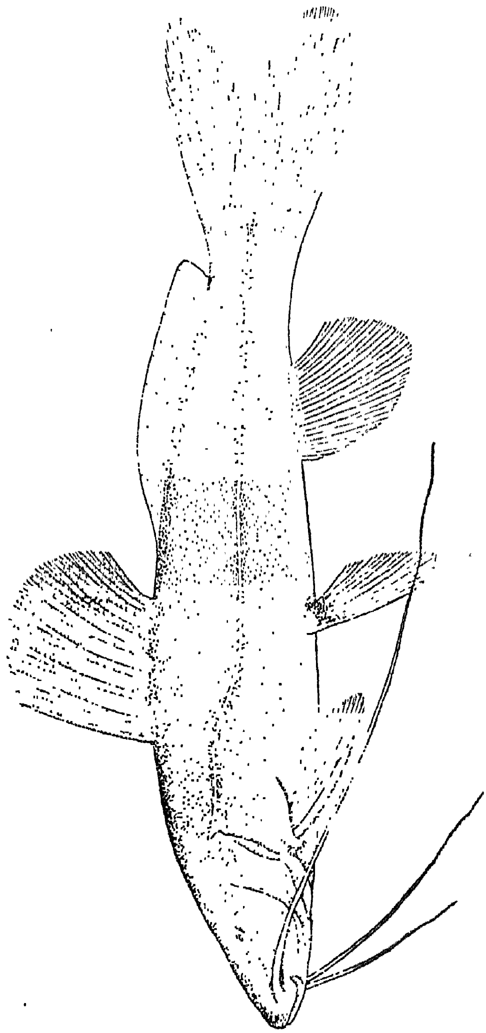


Fig. 1.

Cæcorhamdia urichi, sp. n.

W. P. C. Tenison del.

In order to draw attention to this interesting fish, and following convention, I have erected a new genus for its reception. I realize, however, that this procedure is somewhat unsatisfactory, for, were the eyes developed, the specimens from the Guacharo Cave would probably be identified with the species *Rhamdia queleni*. Similarly, *Typhlobagrus*

kronei, Ribeiro, another blind catfish of the family Pimelodidæ, from São Paulo, S.E. Brazil, is said to be distinguishable from *Pimelodella lateristriga*, Müller and Troschel, only

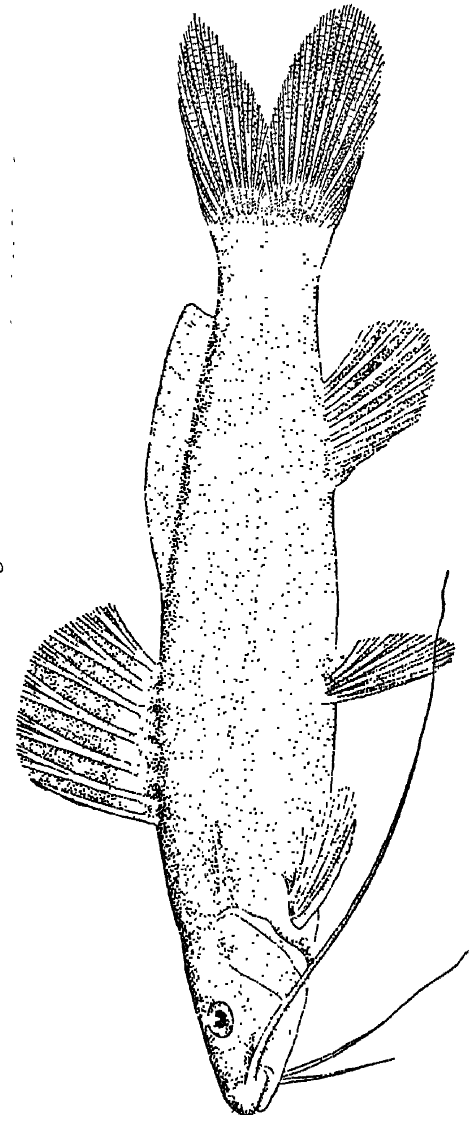


Fig. 2.

Rhamdia Qu nd Gaimard.

W. P. C. T.

by the absence of eyes; indeed Haseman * has expressed the opinion that it should be designated *Pimelodella lateristriga*, var. *kronei*.

* Ann. Carnegie Mus. vii. 1911, p. 323.

Other blind catfishes from North America, belonging to the family Amiuridæ, seem to be sufficiently different from their nearest living relatives to be regarded as distinct species, even if the eyes were present. These are *Gronias nigrilabris*, Cope, and probably also *Trogloglanis pattersoni*, Eigenmann. In both these fishes no trace of the eye-sockets is apparent, but it must be remembered in this connection that the eyes of the Pimelodidæ are normally provided with a free margin, whereas those of the Amiuridæ have no such margin.

The remaining eleven blind fishes included in the list given below would certainly be placed in distinct genera even were the eyes developed. *Cæcobarbus*, for example, differs from *Barbus* not only in the complete absence of eyes, but also in the structure of the scales. In *Phreatichthys*, another blind genus derived from *Barbus*, the scales are entirely wanting.

List of Blind Cave-fishes.

Order OSTARIOPHYSI.

Cyprinidæ.

1. *Cæcobarbus geertsii*, Boulenger, Rev. Zool. Afric. ix. fasc. 3, 1921, p. 252, 1 fig.

Hab. Lake in the Grotto of Thysville, Lower Congo; 700 metres above sea-level.

Related to *Barbus*.

2. *Phreatichthys andruzzii*, Vinciguerra, Ann. Mus. Civ. St. Nat. Genova, li. 1924, p. 239, 2 figs.

Hab. "Sorgente termale Bud-Bud a 4° 11′, 5 Lat. N. e 46° 30′ Long. E. Gr. nella Somalia italiana in territorio Uaesle, presso e confini del Sultanato di Obbia."

Related to *Barbus*.

Amiuridæ.

1. *Gronias nigrilabris*, Cope.

Gronias nigrilabris, Cope, Proc. Acad. Nat. Sci. Philad. 1864, p. 231; Jordan and Gilbert, Bull. U.S. Nat. Mus. xvi. 1882, p. 102.

Amiurus nigrilabris, Jordan, Bull. U.S. Nat. Mus. x. 1877, p. 92; Jordan and Evermann, Bull. U.S. Nat. Mus. xlvii. 1896, p. 142.

Hab. Cave-streams tributary to Conestoga River, Eastern Pennsylvania.

Related to *Amiurus*.

2. *Trogloglanis pattersoni*, Eigenmann, Proc. Amer. Phil. Soc. lviii. 1919, p. 397, 2 figs.

Hab. Artesian well, San Antonio, Texas.
Related to *Schilbeodes*.

Clariidæ.

1. *Uegitglanis zammaranoi*, Gianferrari, Atti Soc. Ital. Sci. Nat. Milano, lxii. 1923, p. 1, pl. i.

Hab. Well at El Uegit, Italian Somaliland.
Related to *Clarias*.

Pimelodidæ.

1. *Typhlobagrus kronei*, Ribeiro.

Typhlobagrus kronei, Ribeiro, Kosmos, no. 1, Jan. 1907; Fauna Bras., Peixes, iv. (A), 1912, p. 250, pl. xlii. figs. 2, 2 A, 2 B; Eigenmann, Mem. Carnegie Mus. vii. 1917, p. 255, pl. xxxiv. fig. 2.
Pimelodella lateristriga, var. *kronei*, Haseman, Ann. Carnegie Mus. vii. 1911, p. 323.

Hab. Cavernas das Areiras, Iporanga, São Paulo, S.E. Brazil.
Related to *Pimelodella*.

2. *Cæcorhamdia urichi*, Norman.

Hab. Guacharo Cave, Trinidad.
Allied to *Rhamdia*.

Trichomycteridæ.

1. *Phreatobius cisternarum*, Goeldi, C. R. Congrès Intern. Zool. Berne, (1904) 1905, p. 545; Fuhrmann, Arch. Sci. Phys. Nat. Genève, (4) xx. 1905, p. 578; Eigenmann, Mem. Carnegie Mus. vii. 1918, p. 372, pl. lvi. figs. 1, 2, 4, text-fig. 39.

Hab. Inland Cistern, Marajo Island, Brazil.
The relationships of this species are uncertain; Eigenmann (Proc. Amer. Phil. Soc. lviii. 1919, p. 398) considers that it may be remotely related to *Heptapterus*, of the family Pimelodidæ.

Order MICROCYPRINI.

Amblyopsidæ *.

. *Amblyopsis spelæus*, De Kay, Nat. Hist. New York, Fishes, p. 187 (1842); Eigenmann, Cave Vertebrates of America, p. 71, pl. v. (1909).

Hab. Subterranean streams of the United States, east of the Mississippi.

2. *Troglichthys rosæ*, Eigenmann.

Typhlichthys rosæ, Eigenmann, Proc. Indian. Acad. Sci. (1897) 1898, p. 231.

Troglichthys rosæ, Eigenmann, Science, n. s. ix. 1899, p. 280; Cave Vertebrates of America, p. 72, pl. vi. figs. A–C (1909).

Hab. Caves and wells in Missouri and Arkansas, U.S.

3. *Typhlichthys subterraneus*, Girard, Proc. Acad. Nat. Sci. Philad. (1859) 1860, p. 63; Eigenmann, Cave Vertebrates of America, p. 73, pl. vi. figs. D–E, text-fig. 28 (1909).

Hab. Subterranean streams in caves in Indiana, Kentucky, Tennessee, Missouri, and Alabama, U.S.

4. *Typhlichthys osborni*, Eigenmann, Biol. Bull. viii. 1905, p. 65, figs. 3–4; Cave Vertebrates of America, p. 74, text-fig. 29 (1909).

Hab. Horse Cave, Kentucky.

5. *Typhlichthys wyandotte*, Eigenmann, Biol. Bull. viii. 1905, p. 63, figs. 1–2; Cave Vertebrates of America, p. 75 (1909).

Hab. Well near Corydon, Indiana.

Order PERCOMORPHI.

Suborder BLENNIOIDEA.

Brotulidæ.

1. *Lucifuga subterraneus*, Poey, Memorias, ii. p. 96 (1856); Jordan and Evermann, Bull. U.S. Nat. Mus. xlvii.

* For full synonymies of the family Amblyopsidæ see Eigenmann, 'Cave Vertebrates of America' (1909). All the blind forms are allied to *Chologaster*.

1898, p. 2501; Eigenmann, Cave Vertebrates of America, p. 185, pls. xv., xxv. A, etc. (1909).

Hab. Cave-streams in Cuba.

2. *Stygicola dentatus*, Poey.

Lucifuga dentatus, Poey, Memorias, ii. p. 102 (1856).
Stygicola dentatus, Gill, Proc. Acad. Nat. Sci. Philad. (1863) 1864, p. 252; Jordan and Evermann, Bull. U.S. Nat. Mus. xlvii. 1898, p. 2500; Eigenmann, Cave Vertebrates of America, p. 185, pls. xiii., xiv. (1909).

Hab. Cave-streams in Cuba.

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXII, 1926, No. 1.

ARTICLE No. 9.

Note on a Hermaphrodite Loach.

By SUNDAR LAL HORA, D.Sc.,
Officiating Superintendent, Zoological Survey of India.

(Communicated by permission of the Director, Zoological Survey of India.)

Several instances of teratological hermaphroditism have been recorded among Teleostean fishes,[1] but so far as I am aware this phenomenon has not been observed among loaches (Cobitidae). Recently while going through the named and unnamed material of the fishes of the genus *Nemachilus* in the collection of the Zoological Survey of India a case of hermaphroditism in *Nemachilus montanus* (McClelland) has come under my notice. In our collection there are three specimens of this species, one is a ripe male, another a ripe female and the third is a hermaphrodite. The last specimen is much larger than the other two and though externally it is provided with certain secondary sexual characters of the male, internally it possesses a well developed ovary and a pair of rudimentary testes. In view of the rarety of such instances, it may be of interest to record the details of this find.

In certain species of *Nemachilus* the male is provided with well-marked secondary sexual characters [2] in the form of a pad below the anterior margin of the eye and a series of spine-like outgrowths on the dorsal aspect of the pectoral fins. The males of *N. montanus* are characterized by the possession of such characters. In the hermaphrodite specimen there is a pad below the eye which is much less developed than that of the normal male and the spines on the pectoral fins are absent. The abnormal condition of the secondary sexual characters, and the relatively large size of the specimen led me to examine its internal organs. On an examination I found that the whole of the body cavity was full of an ovary (the ovaries of the two sides have apparently joined to form a single large ovary) containing well-developed eggs. On the ventral surface of the ovary at the anterior end were found two pale pink, ductless glands one just behind the liver on the left and the other below the stomach on the right side. They were closely pressed against the ovary and

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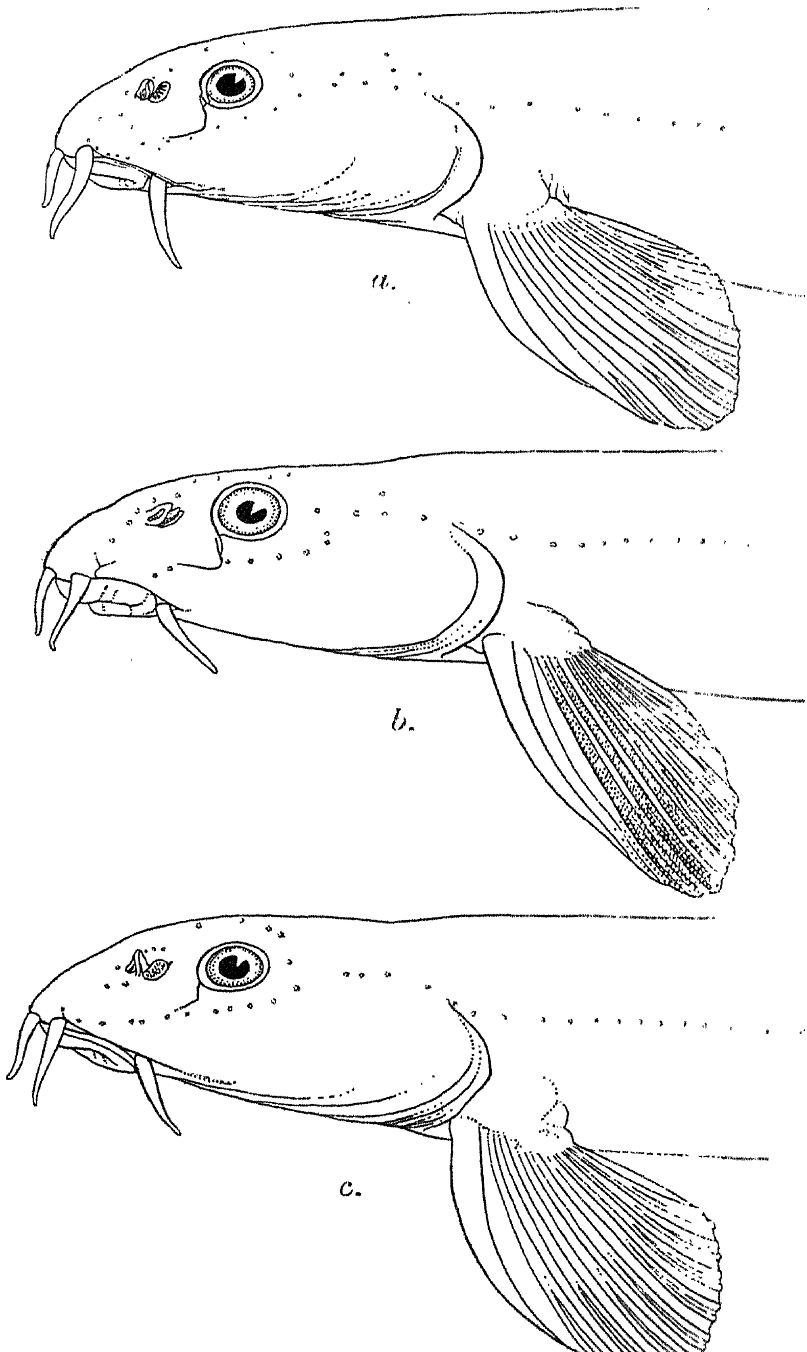
[1] For references see Gemmill's *Teratology of Fishes*, pp. 46-48 (Glasgow: 1912); Dean's *Bibliography of Fishes* III, pp. 503, 504 (New York: 1923); Bounhiol and Pron, *C. R. Acad. Sci. Paris CLXII*, pp. 273-276 (1916) and Bamber, *Proc. Zool. Soc. London*, pp. 216-219, pls. i, ii (1917).

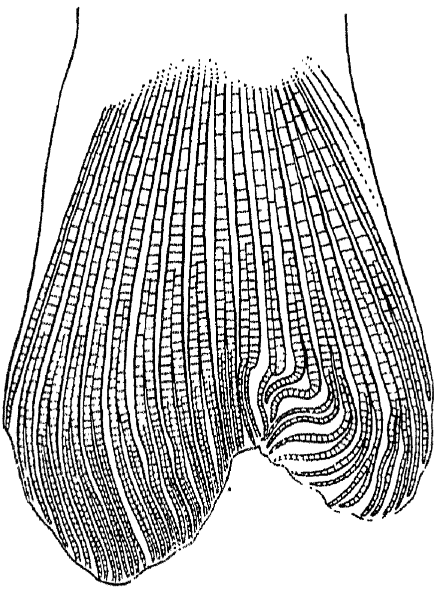
[2] Hora, *Rec. Ind. Mus.* XXIV, pp. 81-83 (1922).



Text-fig. 1.—Lateral view of the anterior part of hermaphrodite, male and female specimens of *Nemachilus montanus* showing secondary sexual characters.
a. Hermaphrodite; *b.* Male; *c.* Female.

when removed left definite depressions in their places. On examining the sections of these glands under the microscope and by comparing them with the sections of the testis of a ripe male they were found to be rudimentary testes. As the tissues were not well preserved for histological details, it is not possible to say much regarding the minute structure of these glands. Moreover, all the specimens were already opened out before this peculiarity was observed so it is difficult to make out the details of the ducts of the ovaries.

The hermaphrodite specimen shows other abnormalities besides the large size, to which I have already referred. The rays of the upper lobe of the caudal fin are deformed, instead of



Text-fig. 2. The deformed caudal fin of the hermaphrodite loach.

being straight and pointing backwards, they are bent downwards at an angle. The colouration is also somewhat different.

I have not been able to observe any connection between the testes and the ovary so it is difficult to decide whether they once formed a continuous gland or not. In Teleostei as a rule among hermaphrodites it is the "differentiation of the same gland into organically continuous ovary and testis."[1] In my specimen ovaries are full of ripe eggs while the testes are ductless and rudimentary. From the nature of the secondary sexual characters it appears to me quite probable that the specimen was a male to begin with and its developing testes induced the formation of the secondary sexual characters. The ovaries,

1 Howes, *Journ. Linn. Soc. London*, XXIII, pp. 539-558 (1891).

which appeared at a somewhat later stage, soon became the dominant factor and checked the growth of the testes and consequently of the secondary sexual characters. From the size of the fish it is also clear that some violent physiological changes in the metabolism must have taken place at the time of change in the sex.

I give below the principal measurements of the specimens to show differences in proportions, etc.

Measurements in Millimetres.

Total length including caudal	64.2 ♂	68.2 ♀	87.0 ⚥
Length of caudal ..	11·0	11·7	15·5
Length of head ..	12·0	12·3	15·0
Depth of body ..	7·8	7·5	12·2
Length of snout ..	5·0	5·0	6·2
Interorbital distance ..	3·0	3·6	4·0
Length of caudal peduncle	6·0	6·8	7·3
Least height of caudal peduncle	5·3	5·8	7·3
Longest ray of dorsal ..	8·1	9·5	10·5
Length of pectoral ..	11·0	10·5	15·0
Length of ventral ..	9·0	9·6	12·0
Longest ray of anal ..	7·7	8·4	9·2
Length of ovary ..		20·5	38·0

The hermaphrodite loach along with the other two specimens was collected by me in the Giri stream near Simla in 1921.

Major Sewell suggests that it is quite probable that the hermaphrodite is an old female in which the secondary sexual characters of the male have just started to appear on account of the failure of the internal secretion from the ovaries due to old age. The size of the specimen also lends considerable weight to this suggestion. This phenomenon is, moreover, not rare among other groups of vertebrates. I am greatly indebted to Major Sewell for going through the manuscript and making valuable suggestions.

Issued August 10*th*, 1927.

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXII, 1926, *No.* 1.

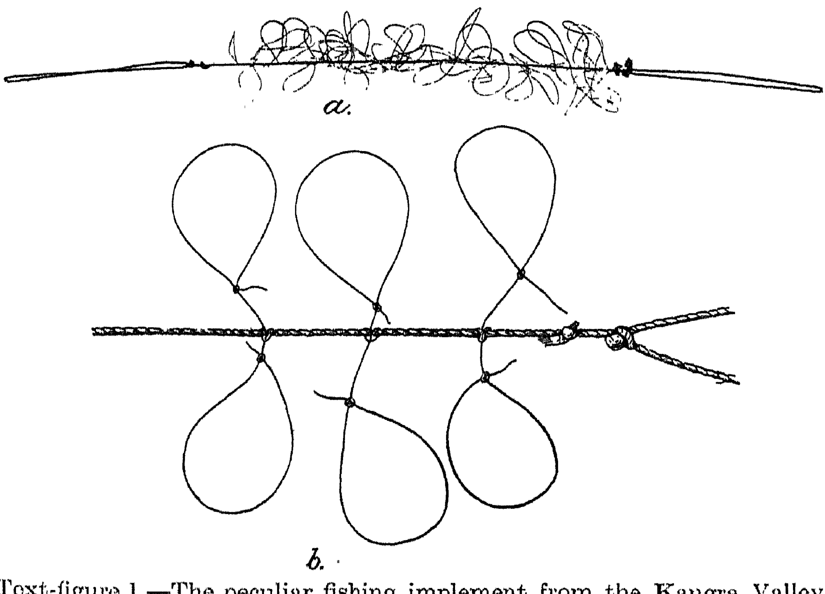
ARTICLE No. 10.

On a Peculiar Fishing Implement from the Kangra Valley, Punjab.

By SUNDER LAL HORA, D.Sc., F. *Officiating Superintendent, Zoological Survey of India.*

(Read at the Fourteenth Annual Meeting of the Indian Science Congress, and published by permission of the Director, Zoological Survey of India.)

During my recent tour to the Kangra Valley (May-June, 1926) an interesting type of fishing implement, locally known as *Kalerni*, has come to my notice. I am greatly indebted to Mr. Prem Das, sub-inspector of fisheries, Kangra, for drawing my attention to it and for getting me a specimen for the [illegible]



Text-figure 1.—The peculiar fishing implement from the Kangra Valley, Punjabi.
a. Photograph of Kalerni (greatly reduced).
b. Sketch showing the type of knots × [illegible].

Museum collection. He has also supplied me with valuable notes about it.

The specimen consists of three pieces of thin hemp twine, each about a foot and a quarter in length. Of these, two pieces are knotted, so that each forms a running noose and are

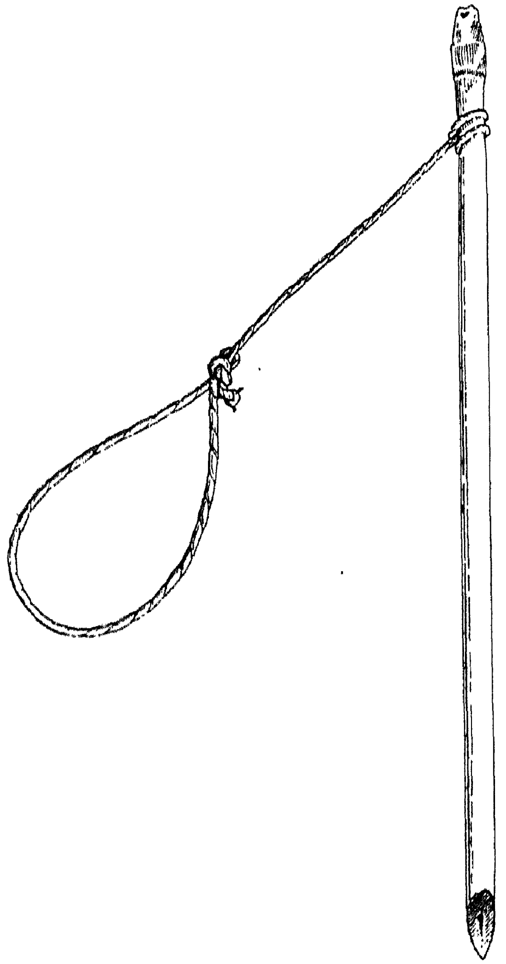
firmly fastened to the two ends of the third central piece. To this piece are tied at irregular intervals a number of horse hair loops with running nooses. For this purpose a long hair is taken and tied to the twine in the centre of its length, the two free halves are then knotted into loops. As many as 30 such double loops are present in the specimen in my possession.

This implement is used in the rapid-flowing waters of our shallow, rocky streams. The fishes of such streams are mostly, bottom feeders and are capable of attaching themselves to rocks and stones by means of suckers and frictional devices of various kinds. They usually dart about from rock to rock and are thus enabled to progress in very swift currents. The other type of fish that frequent the rapids are the powerful migratory fishes like the well known *Mahaseer* (*Barbus tor*, *sensu lato*) and several other species of *Barbus* that migrate up-stream at certain seasons for breeding purposes and return to the plains when the season is over. Owing to the shallowness of the water in the hill streams they have to keep quite close to the bottom when moving about. It is for the capture of such fishes that *Kalerni* is used. It is fixed in the course of a rapid stream among big boulders and rocks by the help of two pieces of stone lodged in loops formed by the two end pieces of twine and securely fastened there by adjusting the position of the sliding knots. The central piece of twine with the horse-hair loops is kept stretched tight. Fish moving up or down the stream are caught in the loops and the creatures in their struggles are then rendered helpless by the mechanical action of the running knots. A fisherman uses about 50 to 100 of such implements at a time and lifts them up after every three or four hours, some possibly containing fish, while others may be quite empty. When the implements are taken out of water after the day's work, the hairs are lubricated with *ghee* (clarified butter) to keep them soft and strong and to prevent them from cracking. During use if any hair gets straightened, it is turned into a loop again before using it next day.

From the fact that a single horse-hair is used to make a loop it is evident that *Kalerni* is only meant for catching small fish. In the Kangra Valley most of fish are of a small size. It is also possible that hill stream fishes with "suckers" do not struggle much because during the greater part of their life they remain quietly sticking to stones As an instance I might cite the case of a species of *Glyptothorax* from Manipur[1] locally known as *Nga-pang* or the innocent fish. This species is said to stick even faster to rocks and stones when touched with something instead of swimming away to safety It is thus very easily secured and hence the name *Nga-pang*.

[1] Hora, *Rec. Ind. Mus.* XXII, p. 173 (1921).

Various kinds of fishing implements have been reported from India and Burma and some of those that are used in the rapid waters of our torrential streams are very ingenious devices, but there is not one which, to the best of my knowledge, agrees



Text-figure 2.—The running Fish-noose (*Aikeghi*) used by the Sema Nagas (greatly reduced). The stick is cut short for convenience.

with *Kalerni* or has anything in common with it. The *Kalerni* is modelled after certain devices that are used all over India, Burma and the adjacent countries for snaring birds. One such device from Java in our collection (No. 6866) is labelled as, " A model of a fishing implement," but Mr. A. Pedler has entered the following

remark in our register against the same number, "Evidently an implement for snaring birds?" An examination of the model leaves no doubt that it must have been an implement for snaring birds and that it could not have been meant for fishing. Dr. Satya Churn Law has informed me that unfortunately our knowledge of the various devices used in bird catching in India is very meagre[1] and it is still more unfortunate that the several interesting specimens of such devices in the collection of the Indian Museum have not, as yet, been reported upon.

Mr. J. H. Hutton has very kindly drawn my attention to a fish-noose used by the Sema Nagas and described by himself.[2] It "consists of a running noose, attached to the end of a stick, which is held in front of a fish swimming in water and jerked tight as it passes through." The running noose in this device consists of fibre (probably of the sago-palm) and Mr. Hutton has informed me that "in slowly running but clear water the contrivance is most effective." Mr. Hutton has presented a specimen of this device for the collection of the Indian Museum (the handle has been cut short for convenience) and I take this opportunity to give an illustration of it here.

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1 Harper, "On Bird-catching in India," *Avic. Mag.* (N.S.) I, pp. 262-268, pl. (1903).

2 Hutton, "The Sema Nagas," p. 82 (London: 1921).

Issued August 10th, 1927.

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXIII, 1927, No. 3.

ARTICLE No. 34.

Remarks on Günther-Day Controversy regarding the Specific Validity of Hamilton-Buchanan's Cyprinus Chagunio.

By SUNDER LAL HORA.

(Published by permission of the Director, Zoological Survey of India, Calcutta.)

In the late sixties and early seventies great controversy raged between Günther and Day, the two eminent British ichthyologists of the period, regarding the relations between *Barbus beavani*, Gthr. and *Cyprinus chagunio* Ham. Buch. The details of this dispute are recorded in the *Proceedings of the Zoological Society, London.* Recently there have come to me certain facts bearing on this point and I have taken the trouble necessary to go into the matter fully. Having the facts at hand I have thought it worth while to make a record of them here.

In 1868, Günther in his Catalogue (VII, p. 96) described *Barbus beavani* from two specimens (one 'adult' 145 mm. and one young) collected in the "Cossye River" and presented to the British Museum by Lieut. R. C. Beavan. At the same time Günther considered *Cyprinus chagunio* of Buchanan a doubtful synonym of *Barbus clavatus* McClelland (p. 97). In 1869, Day while writing notes on the fishes of Orissa (*P.Z.S.*, p. 373) relegated Günther's *beavani* to the synonymy of *chagunio*. A large number of young specimens of the species up to 3·5 inches in length were collected by Day at Midnapore in the Kossye River, but he mentioned that the species is said to grow to 18 inches (Buchanan also mentions that his *chagunio* attains to about a foot and a half in length). In the course of certain "critical observations" made in the "Zoological Record" for 1869 (p. 136) Günther doubted Day's determination and pointed out that "a fish described as having large scales and minute barbels is not likely to be the *B. beavani*" (both the characters referred to here are taken from Buchanan's description of *Chagunio*). In 1871, Day, in order to confirm his determination, referred to the MS. drawing of "? *C. chagunio*" in the possession of the Asiatic Society of Bengal (*P.Z.S*, p. 637), but Günther deferred the consideration of this point in his notes published in 1871 (*P.Z.S.*, p. 764) until he obtained a copy of the drawing referred to by Day. Having obtained an "Accurate tracing in pencil of the drawing" from Mr. J. Wood-Mason, Günther again takes up the subject in 1872 (*P.Z.S.*, pp. 875–878)

and gives a figure of the head and of the dorsal fin of the species. He admits that the species figured by Buchanan is the same as his *beavani,* but he does not consider it to be identical with Buchanan's *chagunio.* His judgment was based on the fact that the barbels in the drawing are not minute as described for *chagunio* and secondly the drawing represents only 11 rays in the dorsal fin and not twelve as in *chagunio.* He also directs attention to the name "*Cyprinus Runt*" given on the drawing.... "a name which does not occur in Hamilton's works, but which is evidently the same as *kunta.*" Lastly Günther points out that *C. kunta* was considered by McClelland (*Ind. Cyprinidæ* p. 340) to be a synonym of *Cyprinus sarana* Ham. Buch. While intimating to the Zoological Society the discovery of "the long-missing papers of Dr. Buchanan on natural history" in 1873, Day offered certain remarks on the "Fishes of Bengal" based on extracts from Dr. Buchanan's manuscript notes (*P.Z.S.*, pp. 743–748). Among his remarks he refers to this controversy again (p. 745) and gives three vernacular names for *chagunio* viz., *Gărhăn* at Puraniya: *Daranggi* of the Tista and *Kunta* of some other places. The following statement occurs in a foot-note on p. 746: "The native name *Chaguni*, employed in the 'Fishes of the Ganges,' finds no place in the MS. notes; but this is by no means a solitary instance. However, in the MS. notes the *Kunta* is the only fish likened to the *C. curmuca*; and in the 'Fishes of the Ganges' the *Chagunio* is the only fish compared to the *Curmuca,* whilst *Kunta* and *Chagunio* are both on the same drawing; the first name is only found in the MS. notes, the second only in the published work." In the *Fishes of India* Day justifies his identification and leaves his critics to answer the following two questions (p. 560): "If *C. kunta* is not *C. chagunio,* what does it represent? and where is the figure of *chagunio*?"

It is, therefore, clear that the points raised in this controversy could be settled if a reference had been found to the local name *Chaguni* in Buchanan's MS. notes. I have great pleasure in announcing that a very clear reference on this point is found in the manuscript volume of the original notes concerning the Gangetic Fishes in the Library of the India Office. The name *Kunta, Chaguni* and *Daranggi* are found in one place above the description (in Latin) of *Cyprinus chaguna,* which name in these notes replaces *Cyprinus kunta. Kunta* appears to be the name of the fish at Dinajpur, *Daranggi* at Baruni and *Chaguni* is the name in the Yamung River. Among the habitats of the species are mentioned Tista, Kosi. The most noteworthy entry here is D. 11; A. 8. How Buchanan came to describe twelve rays in the dorsal fin when he noted down only eleven in his notes is a mystery to me. It has already been shown by Day (*P.Z.S.*, p. 746, 1873) that the descriptions of the Gangetic

Fishes are full of such mistakes. This incidentally clears up another point of contention between Günther and Day. I need to refer here only to the dispute over "Has *Cyprinus bata* (Ham. Buch.) nine or ten branched rays in the dorsal fin?"[1] which can be followed by a perusal of the papers cited above.

There seems to me no doubt that *Barbus beavani* Gthr. is identical with *Cyprinus chagunio* Buchanan. I have verified this fact by an examination of the types of *beavani* in the British Museum of Natural History.

I have referred to this discussion at some length firstly in order to clear the specific validity of *Barbus chagunio* and secondly to direct attention to the great harm that has resulted to science by the withholding from Buchanan of his drawings of natural history objects. It is after a lapse of over a century that an indisputable taxonomic position has now been assigned to a common species of considerable economic importance in India.

I have here to offer my sincere thanks to Mr. J. R. Norman for the facilities so kindly extended to me for work in his department.

British Museum (Nat. Hist.).
August, 1928.

[1] In the original notes there are two entries regarding the number of rays in the dorsal fin. The older one is as follows: "pinna ani radiis 8 dorsi 12," but a later entry is, "radius dorsalibus 11 sen 12 analibus 8."

Issued December 7th, 1928.

Author's Copy.

RECORDS

of the

INDIAN MUSEUM

Vol. XXX, Part I, pp. 37–40.

Notes on Fishes in the Indian Museum. No. XV. Notes on Burmese Fishes.

By

S. L. HORA.

CALCUTTA:
APRIL, 1928.

NOTES ON FISHES IN THE INDIAN MUSEUM.

XV.—NOTES ON BURMESE FISHES.

By SUNDER LAL HORA, *D.Sc., F.L.S., F.Z.S., Assistant Superintendent, Zoological Survey of India, Calcutta.*

Recently I had an opportunity of determining several small lots of fish from different parts of Burma for the Director, Harcourt Butler Institute of Public Health, Burma. Among these I found examples of *Barbus* (*Puntius*) *binotatus* (C.V.), *Ctenogobius alcocki* (Annandale) and of a new species of the subgenus *Brachydanio*. Of the last species several specimens were also collected by Dr. H. S. Rao in the Northern Shan States. In this paper I propose to write notes on these forms and to include the description of another new species of *Brachydanio* collected by Dr. B. N. Chopra in the Myitkyina District, Upper Burma.

Ctenogobius alcocki (Annandale).

1906. *Gobius alcocki*, Annandale, *Journ. As. Soc. Bengal* (n. s.) II, p. 201, fig. 1.
1923. *Ctenogobius alcocki*, Hora, *Mem. Ind. Mus.* V, p. 774.

Ctenogobius alcocki has hitherto been recorded from Port Canning, Calcutta and the Chilka Lake. Dr. B. N. Chopra and I collected several specimens of this species in a small tidal channel beyond the sacred temple at Puri. I have here to record its occurrence at Rangoon. The species was collected in a tank full of vegetation and situated to the west of the Harcourt Butler Institute of Public Health, Burma.

Barbus (Puntius) binctatus (C.V.).

1878. *Barbus goniosoma*, Day, *Fish. India*, p. 562, pl. cxxxvii, fig. 2.
1916. *Puntius binotatus*, Weber and Beaufort, *Fish. Indo-Austral. Archipel.* III, p. 186, fig. 74.

Barbus (*Puntius*) *binotatus* exhibits considerable individual variation both as regards the form of its body and its colouration. According to Weber and Beaufort this species is only found in "Sumatra, Nias, Java, Bali, Lombok, Borneo, Banka, Biliton, Singapore, Malacca, Philippines," for they did not recognize that the form described by Day as *Barbus goniosoma* from Mergui was synonymous with *B. binotatus*. I have examined two of Day's original specimens from Mergui and a number of half-grown examples from Kambanta, Tavoy district, and find that they agree with Weber and Beaufort's description of *Puntius binotatus* in every essential detail. In certain examples from Tavoy there is an indication of a black spot at the base of the anterior dorsal ray and another still more indistinct spot at the base of the caudal. The colouration is silvery except for the tips of the dorsal, anal and caudal fins which are grayish.

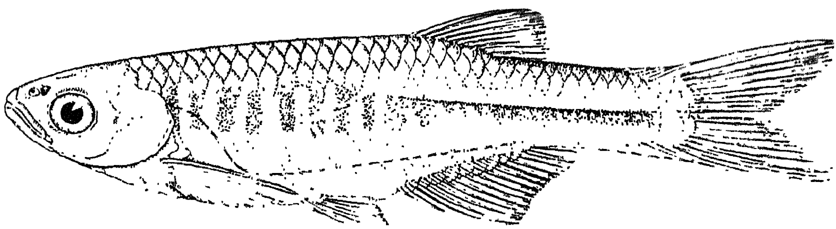
For convenience of reference I give below measurements in millimetres of some of these examples :—

	Mergui.		Tavoy.	
Total length without caudal	95·5	96·0	75·3	62·0
Length of head	26·1	25·3	21·7	18·3
Depth of body	35·4	37·0	26·5	21·2
Length of snout	7·6	7·9	5·7	5·6
Diameter of eye	8·2	7·8	6·2	6·0
Interorbital width	10·5	9·5	7·8	6·5
Longest ray of dorsal	23·0	24·0	16·7	15·5
Longest ray of anal	14·5	14·3	11·5	10·6
Length of pectoral	20·5	20·0	15·8	15·0
Length of ventral	18·0	18·5	14·0	13·3

Danio (Brachydanio) shanensis, sp. nov.

D. 2/7 ; A. 3/10-12 ; P. 13 ; V. 8 ; C. 18.

Danio (*Brachydanio*) *shanensis* is a small species in which the dorsal profile rises gently from the tip of the snout to the commencement of the dorsal fin, beyond which it slopes down to the base of the caudal.



TEXT-FIG. 1.—Lateral view of *Danio* (*Brachydanio*) *shanensis*, sp. nov. × 3.

The ventral profile is arched, except in the region of the caudal peduncle, where it runs parallel to the dorsal profile. The body is greatly compressed from side to side and the head is somewhat pointed. The length of the head is contained 3·8 to 4 times and the depth of the body 3·3 to 3·7 times in the total length without the caudal. The diameter of the eye is contained 3 to 3·5 times in the length of the head ; it is almost equal to the length of the snout and is contained about 1·5 times in the interorbital width. The barbels are generally absent but in some specimens a pair of short, stumpy barbels are present at the corners of the mouth. The mouth is obliquely directed upwards and is of moderate width. There are 10 short, stout and rather widely set gill-rakers. The commencement of the dorsal is slightly behind that of the anal and its longest ray is equal to the head without the snout ; it has 2 spines and 7 branched rays, the last being split to the base. The anal fin contains 3 spines and 10-12 branched rays, the last being split to the base. The pectoral is shorter than the head and just reaches the ventral, which does not extend to the base of the anal. Both the paired fins are provided with short appendages at their bases. The caudal fin is deeply emarginate and is longer than the head. The scales are very thin and are hardly distinguishable in young specimens. There

are 34 scales in a longitudinal row and there are 8 rows in a transverse series. The scales are marked with longitudinal lines. The bases of the anal and the caudal fins are covered with thin scales. There are 17 predorsal scales. The least height of the caudal peduncle is contained 1·6 to 1·9 times in its length ; there are 10 scales round the caudal peduncle. The lateral line is incomplete. From the upper angle of the gill-cover it turns abruptly downwards and is then continued in the lower half of the body for a considerable distance, but it never reaches the base of the caudal fin.

The colouration is very characteristic of the species. It possesses a broad, lateral band of a dark colour which becomes narrower posteriorly. With age it is broken up into a number of vertical bars anteriorly and the intervening spaces between these become silvery. There is a black streak along the back and the edges of the scales in the upper half are covered with black dots. The general colouration is pale olivaceous. The fins are diaphanous. In very young specimens the colouring is silvery all over.

Type-specimen :—F 10814/1, *Zoological Survey of India* (*Ind. Mus.*).

The species seems to be quite common in the Northern Shan States. Dr. H. S. Rao collected a large number of specimens in rice fields, in pools and ditches in the bed of hill streams at Namkhan, Kutkai, Lashio and Hsipaw.

Measurements in millimetres.

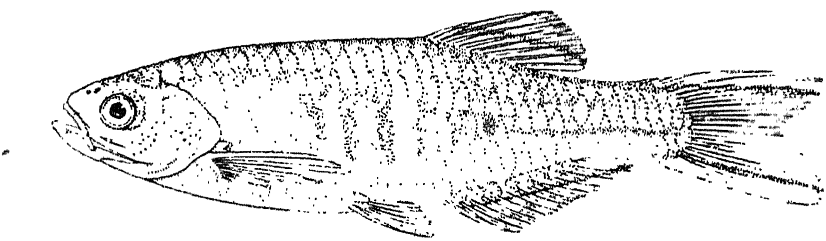
Total length without caudal	30·0	33·0	38·0
Length of head	7·4	8·0	10·0
Height of body	8·2	8·8	11·5
Length of snout	2·2	2·3	3·3
Diameter of eye	2·2	2·4	3·0
Interorbital width	3·4	3·4	4·4
Length of pectoral	6·2	6·8	8·1
Length of ventral	4·0	4·8	5·7
Length of caudal peduncle	6·8	7·7	8·0
Least height of caudal peduncle	3·5	4·2	5·0

Danio (Brachydanio) choprae, sp. nov.

D. 2/7 ; A. 3/12-13 ; P. 13 ; V. 7 ; C. 20.

Danio (*Brachydanio*) *choprae* is a small species not more than 30 mm. in length. Both the dorsal and the ventral profiles are slightly arched. The body is compressed from side to side and the head is somewhat pointed. The length of the head is contained from 4 to 4·2 times and the depth of the body 3·2 to 3·5 times in the total length without the caudal. The diameter of the eye is very variable ; it is contained from 2·5 to 3·5 times in the length of the head. The snout is considerably shorter than the diameter of the eye, which is contained from 1·3 to 1·5 times in the interorbital width. There are two pairs of well-developed barbels. The rostral barbel originates just in front of the nares and for the greater part of its length lies in a groove ; it is almost as long as the diameter of the eye. The maxillary barbel is much longer than the eye. The mouth is obliquely directed upwards and is of moderate

width. The gill-rakers are short and widely set. The commencement of the dorsal is opposite that of the anal; its longest ray is considerably shorter than the head; it contains 2 spines and 7 branched rays. The anal fin contains 3 spines and 12 to 13 branched rays. The pectoral is slightly shorter than the head and just touches the base of the ventral, which is separated from the anal by a short distance. There is a short fleshy appendage at the base of the pectoral and a scaly appendage at the base of the ventral. The caudal fin is emarginate and longer than the head. The scales are thin and hardly visible in young specimens. There are 33 scales in a longitudinal row and there are 7 rows transversely arranged on the body. The base of the anal fin is covered with scales. There are 15 predorsal scales. The minimum height of the caudal peduncle is contained 1·3 to 1·7 times in its length; there are 10 scales round the caudal peduncle. The lateral line is absent.



TEXT-FIG. 2.—Lateral view of *Danio* (*Brachydanio*) *choprae*, sp. nov. × 3⅔.

Danio choprae has a very characteristic colouration. It is pale olivaceous, the upper surface being much darker than the lower. Anteriorly there are several dark, broad, vertical bars which grow shorter in length as they recede backwards till they are reduced to mere dots, and in continuation of these there is a dark longitudinal stripe to the base of the caudal. There are two indistinct longitudinal bands in the upper half of the body and a black streak along the back. Both the dorsal and the anal fins are provided with longitudinal bands across their rays. Each lobe of the caudal fin possesses a longitudinal black band. The fins are, otherwise, quite transparent.

Type-specimen :—F 10811/1, *Zoological Survey of India* (*Ind. Mus.*).

Several specimens of this new species were collected by Dr. B. N. Chopra in small rocky streams about Kamaing and Namma in the Myitkyina District, Upper Burma.

Measurements in millimetres.

Total length without caudal	20·5	20·5	21·0
Length of head	5·0	5·1	5·0
Height of body	5·7	6·0	6·4
Length of snout	1·6	1·6	1·6
Diameter of eye	2·0	2·0	1·8
Interorbital width	2·8	2·7	2·8
Length of pectoral	4·7	5·0	4·5
Length of ventral	3·0	3·0	3·0
Length of caudal peduncle	4·0	4·0	4·0
Least height of caudal peduncle	2·4	3·0	2·8

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXIV, 1928, No. 4.
Issued 10th September, 1929.

The Habitat and Systematic Position of two imperfectly known Loaches from Afghanistan.

By SUNDER LAL HORA.

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXIV, 1928, No. 4.

ARTICLE NO. 14

The Habitat and Systematic Position of two imperfectly known Loaches from Afghanistan.

By SUNDER LAL HORA.

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While studying the Indian material of the genus *Nemachilus* in the collection of the British Museum of Natural History I had an opportunity of examining the type-specimens of *N. boutanensis* (McClelland) and *N. griffithii* Günther. On the bottles containing these unique specimens there are to be found old labels in the same handwriting giving the locality of the species as "Affghan," though on labels of an undoubtedly later date the localities mentioned are "Butan" and "Assam" respectively as noted by Günther in his *Catalogue*. No further information could be obtained from the old registers of the fish collection in the Museum, but it has been possible for me to trace these specimens back to Griffith's field notes with the following interesting results.

In a general list of the specimens contained in Griffith's collection, McClelland (*Calcutta Journ. Nat. Hist.* II, pp. 573-575, 1842) has indicated the species of which examples were despatched "to the Museum at the India House" by placing the numbers of specimens despatched in Roman numerals after the names. A careful perusal of this list has indicated that McClelland sent to England specimens of two species of *Cobitis* —C. *boutanensis* and *C. marmorata*. On reference to Günther's *Catalogue* (VII, pp. 358, 360) it is clear that the author had specimens of only two species of *Nemachilus* from Griffith's collection—*N. boutanensis* and *N griffithii*. Thus there can hardly be any doubt that the examples of the two species sent by McClelland served later on for the descriptions of the two species by Günther.

On referring to "Mr. Griffith's own remarks on the fishes he met with in Affghanistan and adjoining provinces" (*Calcutta Journ. Nat. Hist.* II, pp. 562-567, 1842) the following entries are to be found regarding the Loaches obtained by him.

i. 1 Loach at Quettah.

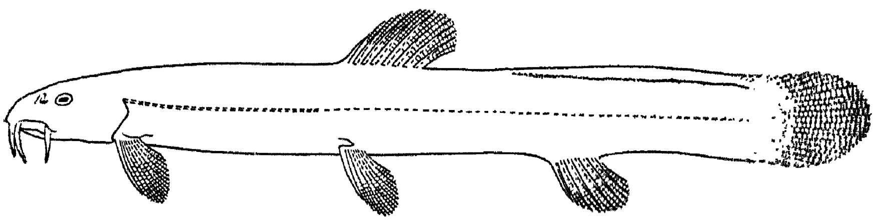
ii. "1 Loach of largish size, with a flat head colour reddish, with conspicuous brownish mottlings." This fish was obtained from "the Arghandab, a rapid and considerable sized tributary of the Helmund, which runs within two or three miles of Candahar."

iii. "In the small channels by which the springs run off, a loach is very common." Here the reference is to the springs at

Sir-i-Chushmah. The loach is also said to occur "in the Helmund at Gridun Dewar, altitude 10,500 feet."

iv. "The only other fish I have any knowledge of, inhabiting the waters of Toorkistan face of the Koh-i-Baba, is a Loach found at Kaloo, at an elevation of 11,000 feet."

It is well known that a great portion of Griffith's collection was lost and in view of the scanty particulars available of the existing material it is difficult to say with certainty which of the above mentioned Loaches represent *N. boutanensis* and *N. griffithii*. McClelland (*op. cit.*) in his account of Griffith's collection refers to a species of *Cobitis* ("probably *Cobitis armatis*,?" p. 582. This seems to be a species of *Botia*) from Loodianah and described *Cobitis boutanensis* from "Boutan, on the Mishmee Mountains" (p. 586). To me it seems likely that Boutan is a misreading of Bolan on the part of McClelland and that he confused the two localities in his account, for it can be seen from McClelland's own introductory remarks that Griffith collected specimens from "the Bolan Pass to the Helmund." Moreover "Boutan" or "Butan" probably refers to the Bhutan State (27.0 N; 91.0 E) which is a long distance away from the Mishmi Hill (28.12 N; 96.20 E).

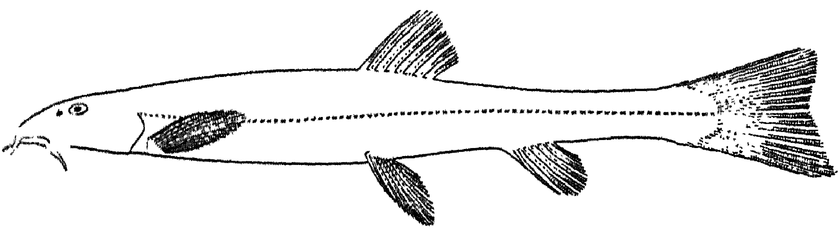


Text-fig. 1.—Lateral view of the type-specimen of *Adiposia boutanensis* (McClelland) x$\frac{5}{6}$.

The type-specimen of *Nemachilus boutanensis* (*Brit. Mus.* No. 60.3.19. 775) bears a close resemblance to the fishes of the genus *Adiposia* described by Annandale and myself from the Helmand Basin, Seistan (*Rec. Ind. Mus.*, XVIII, p. 182, 1920) In the general build of its body and in the character of the adipose fin it is remarkably similar to *Adiposia rhadinaea*, from which it differs in the possession of distinct, imbricate scales, in the absence of lateral line beyond the base of the ventral fin and in its characteristic rounded caudal fin. Thus it would seem probable that *N. boutanensis* is also an inhabitant of the Helmand Basin (near Bolan Pass) and is rightly labelled on the old label as having been obtained in "Affghanistan"

Regarding *N. griffithii* I entertain no doubt that this is the fish collected by Griffith at Arghandab and so clearly described by him as of "a largish size, with a flat head, colour reddish, with conspicuous brownish mottlings." There also seems no

doubt that this must have been the fish determined by McClelland as "*Cobitis marmoratus*" in his list. According to Day (*Fish. India*, p. 621), who examined the type-specimens of *N. griffithii* in the British Museum (No. 60.3.19.93-94)[1] this species is synonymous with *N. stoliczkae*. In an earlier paper (*Rec. Ind. Mus.*, XXIV, p. 78, 1922) it has already been indicated by me that Day's "*N. stoliczkae*" is a composite species and it was possible for me to recognise several forms among the material assigned by Day to *N. stoliczkae*. I have compared in detail the types of *N. griffithii* with a typical specimen of *N. stoliczkae* from Rupshu in Tibet (the type-locality of the species) and find that the two are distinct. In *N. griffithii* the head is contained five times in the length without the caudal, the ventrals just reach the anus and are separated from the



Text-fig. 2.—Lateral view of the type-specimen of *Nemachilus griffithii* Günther x$\frac{2}{3}$.

anal fin by a considerable distance; whereas in *N. stoliczkae* the head is contained little over four times in the length without the caudal, the ventrals extend considerably beyond the anus and reach the origin of the anal fin. Moreover, in *N. stoliczkae* the barbels are much longer, the outer rostral being as long as the snout; whereas in *N. griffithii* the outer rostral is 2/3 the length of the snout. In their general facies and colouration the two species are similar. *N. griffithii* also bears a close resemblance to *N. brauhi* Zugmayer from "Kelat." The latter, however, possesses a much longer head (five in total length), a deeper caudal peduncle (half as high as long) and the ventrals passing the anal opening. The above account leaves no doubt that *N. griffihii* is an Afghan fish and not an Assamese Loach as surmised by Günther.

SUMMARY.

i. *Nemachilus boutanensis* (McClelland) is a species of *Adiposia* collected by Griffith in the Helmand Basin probably in the neighbourhood of the Bolan Pass. It is erroneously said to have come from "Boutan" or "Butan."

[1] According to the list only one example of *Cobitis marmaratus* was sent to England, but this is evidently a mistake in printing overlooked by McClelland.

ii. *Nemachilus griffithii* Günther is a distinct species bearing resemblance to *N. stoliczkae* and *N. brauhi.* It was obtained by Griffith in Afghanistan in the neighbourhood of "Candahar" and is not an Assamese Loach.

London,
September, 1928.

Issued September 10th, 1929.

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXVII, 1931, No. 1.

ARTICLE No. 6.

Buchanan's Ichthyological Manuscript entitled "*Piscium Bengalae Inferioris Delineationes.*"

BY SUNDER LAL HORA.

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Early this year Mr. Gilbert P. Whitley, Ichthyologist at the Australian Museum, presented to the Asiatic Society of Bengal the unique and hitherto unknown manuscript entitled "Piscium Bengalae inferioris Delineationes septuaginta octo" by Dr. Francis Buchanan (afterwards Francis Hamilton). The manuscript is of special interest to the students of Indian Ichthyology, and particularly to workers in Calcutta, as most of the species detailed in the manuscript were obtained in its neighbourhood. The vernacular names of fishes given in the manuscript are those that were current at the time in Calcutta, Khulna, Luckipoor, and the neighbouring villages of Bengal. Though a number of the scientific names[1] employed in the manuscript were never published, it is possible[2] to refer these species to their published accounts in the "Gangetic Fishes" with the help of their local names. The manuscript also provides further material to clear the controversy regarding Buchanan's fish drawings and the use made of them in connection with the study of Indian fishes.

[1] In the list of species at the end I have given the MS. scientific names in order to clear up certain points in connection with the specific limits of the species described in the "Gangetic Fishes". As Buchanan's earlier correspondence, "Original Notes" and his delineations bear these names it has been thought advisable to publish them even at the risk of introducing a large number of still-born new names. Day in publishing an account of the Fish and Fisheries of Bengal (Hunter's *Statistical Account of Bengal*, XX, 1877) gave a number of Buchanan's MS. names. Very fortunately they have been left alone and not introduced into synonymies. I hope the names that are being published now will also receive a similar treatment. Their utility lies in a different sphere altogether and they are not of much importance for purposes of synonymies.

[2] In the volume of original notes concerning the "Gangetic Fishes" (now preserved in the library of the India Office, London) the vernacular names of the species are given below the scientific names. Moreover, these "original notes" contain the earlier scientific names under which Buchanan intended to describe the various species. It is with the help of these "original notes" that I have been able to refer all the species in the manuscript to the published scientific names under which they have been described in the "Gangetic Fishes".

Having already reported on Buchanan's fish-drawings[1] in the library of the Asiatic Society of Bengal as well as in the various libraries in London, I take this opportunity to make a few comments on this valuable manuscript for convenience of reference in future. I have here to offer my sincere thanks to Mr. Gilbert P. Whitley for communicating to me his most valuable discovery with the least possible delay, and for sending the manuscript to me for study while I was in London last year.

THE MANUSCRIPT.

The manuscript is in the form of a bound volume and the numbered sheets in it total 78, each sheet being devoted to the description of one species. Besides there is one loose sheet marked 37 *, which contains the description of *Polynemus paradiseus* L. There are two more unnumbered sheets, one devoted to the index and the other to an introduction to the descriptive matter following. The descriptions of species as well as the introduction are in Buchanan's handwriting, whereas the index, which is full of errors in spellings, etc., is written in a different hand. This is further clear from the fact that the sheets in Buchanan's handwriting are watermarked 1794,[2] whereas the index sheet as well as the blank sheet at the end are watermarked 1798. Though Buchanan had intended to describe only 78 species in this work as is clear from the title, the index contains a list of 85 species. The discrepancy between these two numbers will be explained later (p. 127). The whole of the manuscript is written in Latin, and the introduction, of which I give below a free English translation, explains the object of this work. Introduction runs as follows:—

"Seventy-eight Descriptions of the Fishes of Lower Bengal.
"By Francis Buchanan, M.D.
"The Illustrations by Haludar, a Bengal youth.

"To the kind Reader:

"There are many fishes of Lower Bengal which are not described in this work, but although my business has now called me to a distant region I am unwilling that the work which I undertook of describing these fishes should be entirely wasted. Therefore I entrusted the work to Dr. John Fleming, whose kindness towards me is well known, and I obtained from him, previous to his departure for England, a promise that he would undertake the publication of it.

[1] Hora, *Journ. Asiat. Soc. Bengal* (N.S.), XXII, pp. 99–115 (1927); *Mem. Ind. Mus.*, IX, pp. 169–192, pls. xiii–xxiii (1929).

[2] It is worthy of remark that Dr. Francis Buchanan entered the service of the Honourable East India Company as an Assistant Surgeon on the Bengal Establishment on 26th September, 1794.

"I possessed but few books on fishes, so that I paid little attention to synonymy as being beyond my scope, but I have striven to figure in its natural colours every fish that came before me; indeed, while they were still alive in the water: and my description has always been the result of my personal examination of a recently captured specimen, a result which few ichthyologists writing on the fishes of India have been able to obtain. The Bengal names which are found among the descriptions are to be cited but that which follows the Bengal characters below the figures is put into English, using Dr. Halhed's method, as laid down in his *Bengali Grammar*. Dated Baruipur, January 3rd, 1800."

Buchanan's Early Interest in the Fishes of the Ganges.

It has been pointed out by Sir David Prain in his "Sketch of the life of Francis Hamilton" (p. xi, 1904) that Buchanan became interested in the study of Gangetic fishes while he was stationed at Puttahaut six miles north of Luckipoor. Buchanan resided at Puttahaut from the latter half of 1796 up to a considerable part of 1798. In the manuscript under report the habitat of several species is given as "Habitat in fluviis et stagnis Luccapurae", and, moreover, the local names then current at Luckipoor are given in the manuscript for several species of fish. Further it is clear from a letter to Roxburgh, dated 30th November, 1797, that at Puttahaut Buchanan was having drawings of fish made, for he says:—

"I have given my old painter a gold mohur a month and have him employed on fishes."

It is gratifying to note that the artist who made the exquisite illustrations of "Gangetic Fishes" was a Bengali young man by the name of Haludar. The science of Ichthyology is greatly indebted to this craftsman for his faithful delineations of Buchanan's species, for it is well known that Buchanan's species can be recognised much more easily from his drawings than from his descriptions. There is no doubt that Buchanan must have trained this young man for his work because in the above quoted letter he says:—

"I am attempting to make him do the outlines with some degree of accuracy; when he succeeds in that I shall begin to colour."

That shows the state of affairs in 1797, but it seems probable that by the beginning of 1800 his artist had become fairly competent. In the manuscript, however, Buchanan gives full credit to Haludar for all the 78 drawings illustrating his species.

Buchanan pursued more steadily his investigation of fishes while he was stationed at Baruipur in the 24 Pergunnahs, not far from Calcutta, from the beginning of October, 1798, till the

commencement of 1800. It was at Baruipur that Buchanan conceived the idea of publishing an illustrated work on the fishes of the Ganges. This is clear from Buchanan's letter to Smith (Hora, *op. cit.*, 1929, p. 172) dated the 1st of January, 1799, in which he says:—

"Having at Luckipoor examined all the plants, I began to describe and draw fishes and have collected a good many. As a specimen Captain Burt of the *Duke of Montrose* will forward descriptions and drawings of 10 Cyprini................ When you have looked over these performances you will be able to inform me what I can do with them. If you think the whole would bear the expense of publication I would send you all that I have got. By next season I should suppose that I may have ready nearly 200 drawings of fishes."

It is probable that Smith advised Buchanan to publish his account of fishes in one volume, and the result seems to have been the manuscript dealt with here. There is no doubt, however, that Buchanan was not able to make as much progress with his fishes as he had anticipated when writing the above letter, for he seems to have had descriptions and drawings of only 78 species (instead of 200) by the beginning of 1800. Dr. John Fleming, who had undertaken the publication of the manuscript, was to seek the advice and assistance of Smith while in England, as is clear from Buchanan's letters to Smith dated the 3rd March, 1802, from Bassaria and dated 8th October, 1802, from Katmandu (Hora, *op. cit.*, 1929, p. 172).

Interruption of Buchanan's Investigation of Fishes.

In the introductory part of the manuscript Buchanan refers to some business that necessitated his going to a distant region. Evidently he is referring here to an opportunity that was offered to him of visiting Nepal, and his letter to Roxburgh dated Gorasan, 12th February, 1800, shows that he was able to set out on this journey, which had to be given up at the time as Buchanan was recalled from the Nepal frontier, and instructions, dated 24th February, 1800, were issued to him to visit and report on the territories of the Rajah of Mysore and on the country acquired by the Company after their war with the Sultan, as well as on that part of Malabar previously occupied by Marquis Cornwallis.

After a short stay in Calcutta Buchanan sailed for Madras leaving that place on 23rd April, 1800, to carry out the comprehensive instructions regarding the survey of the newly acquired territories. After the completion of his survey[1] Buchanan

[1] Descriptions and figures of 3 species of fish—*Cyprinus bendilisis*, *C. ariza* and *C. curmuca*—were published by Buchanan in his *Mysore Journey*, Vol. III (1807).

returned to Madras on the 6th July, 1801, and thereafter came back to Calcutta. Shortly after Buchanan's return to Calcutta he was appointed to accompany the embassy that had been despatched under Captain Knox to the Court of Nepal. Buchanan was able to leave Calcutta for Nepal in the cold weather of 1801-02. It is certain that during his short stays at Calcutta on his recall from the Nepal journey and after his return from Madras, Buchanan had opportunities to see the manuscript and make alterations in certain scientific names which are noted in pencil in Buchanan's own handwriting. It is also probable that during these short visits Buchanan may have supplemented his manuscript by the addition of the descriptions of 7 more species, though only one of these is now preserved on a loose sheet; the names of the additional species are included in the index.

Mr. A. F. M. Abdul Ali, Keeper of the Imperial Records, has very kindly informed me that Dr. John Fleming embarked for Europe on the 24th December, 1802, on the Company's ship *Lady Jane Dundas*. It is thus clear that though Buchanan entrusted the manuscript to Fleming early in 1800, it did not leave the shores of India till December, 1802.

It is impossible to say why the whole of this manuscript or suitable portions of it were not published at the time. But the fact remains that after the manuscript left India no more was heard of it till 1931, when Mr. Gilbert P. Whitley (through his friend Mr. Melbourne Ward, who was in England searching for a copy of the "Gangetic Fishes"—G. P. W.) purchased it from Messrs. Wheldon & Wesley, London.

Buchanan returned from Nepal in March, 1803, and took up his old appointment at Baruipur, but in the cold weather of 1803-04 he was put in charge of the menagerie at Barrackpur. He continued in this appointment till the end of 1805 when he went to England. He returned to Calcutta early in 1807, and in the following September he was entrusted with the Survey of Bengal which he carried out till the end of 1814. It has been pointed out by Sir David Prain (p. xlii) that Buchanan's drawings and descriptions of fishes of the Survey period were supplementary to those made by himself when stationed at Puttahaut and Baruipur. Buchanan undoubtedly had his original notes on fishes with him as is clear from the local names of fishes mentioned in them, and I presume that he got back the drawings that may have accompanied the manuscript under report to England. So whoever had the manuscript, he had no drawings of fish to illustrate it, for I believe that Buchanan very rarely had duplicates[1] made of his fish drawings.

[1] It has already been shown that Buchanan had drawings made of 226 species in all, including that of *Muraena serpens*. So far as I have

Further Particulars concerning Buchanan's Fish Drawings.

Buchanan has remarked in the introduction that he had striven to figure in its natural colours *every fish* that came before him. This was possible for him to do at Puttahaut and Baruipur, but during the Survey period, when he must have been constantly on the move, this procedure would not have been possible. I have explained elsewhere (Hora, 1929, p. 178) why of the 272 species described in the "Gangetic Fishes" Buchanan did not make drawings of 47 species. In any case it is certain that Buchanan had drawings made of the seventy-eight species described in this manuscript. Of the additional seven species enlisted in the index, drawings of two, *viz. Polynemus risua* and *Mugil cephalus ?*, were not made.

In the "Gangetic Fishes" 97 species[1] are illustrated. A reference to the table at the end shows that of these 72 are the same as are described in the present manuscript. The drawings of the remaining 6 species of the manuscript are now preserved as follows:—5, which Buchanan had with him but did not publish, are in the library of the India Office, London; whereas one drawing of *Cobitis guntea*, now preserved in the library of the Asiatic Society of Bengal, he seems to have left behind in India with the set of the Survey period presumably through oversight. Of the 5 drawings of the supplementary list of 7 species he had with him in England drawings of *Cyprinus (Bangana) mrigala* and *Muraena serpens*, both are published in the "Gangetic Fishes" though the latter species is not described anywhere in the work. I presume that the drawings of *Mugil albula ?*, *Cyprinus (Cyprinus) gonius* and *C. (Bangana) reba* were also made at Buchanan's expense and that, through oversight or purposely, he left these behind together with the set of drawings of the Survey period.

In the "Gangetic Fishes" there are illustrations of 97 species and, as has been explained above, 73 of these are those of which Buchanan had drawings made at his own expense. The remaining 24, which are listed below, undoubtedly belong to the Survey period. With the exception of *Chanda lala* all had duplicate drawings. That Buchanan in carrying away these drawings did not deprive the Government of Bengal of

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been able to ascertain he had duplicates made of only 33 species, out of which 10 were made at his expense and were sent to Smith with his letter of 1st January, 1799 (9 of these are now preserved in the library of the *Linnean Society of London*); whereas the remaining 23 listed on p. 129 were executed during the Survey period at the Government expense, and were taken by Buchanan with him to England in 1815 to illustrate his "Gangetic Fishes".

[1] I have left out of calculation the drawing of "*Muraena serpens*" reproduced on pl. v, fig. 5, as the species is nowhere described in the work.

the original drawings can be readily made out by referring to the table at the end of my paper published in 1929. The original drawings of the 23 species are now preserved in the library of the Asiatic Society of Bengal. The following is the list of the 24 species mentioned above :—

1. *Batrachoides gangene*, p. 34, pl. xiv, fig. 8.
2. *Ophiocephalus wrahl ?*, p. 60, pl. xxxi, fig. 17.
3. *Ophiocephalus barca*, p. 67, pl. xxxv, fig. 20.
4. *Ophiocephalus aurantiacus*, p. 69, pl. xxiii, fig. 22.
5. *Chanda lala*, p. 114, pl. xxi, fig. 39.
6. *Platystacus chaca*, p. 140, pl. xxviii, fig. 43.
7. *Silurus (Callichrous) pabo*, p. 153, pl. xxii, fig. 48.
8. *Pimelodus rama*, p. 176, pl. iii, fig. 55.
9. *Pimelodus viridescens*, p. 173, pl. xi, fig. 56.
10. *Pimelodus cenia*, p. 174, pl. xxxi, fig. 57.
11. *Pimelodus tengana*, p. 176, pl. xxxix, fig. 58.
12. *Pimelodus carcio*, p. 181, pl. xxiii, fig. 60.
13. *Pimelodus nangra*, p. 193, pl. xi, fig. 63.
14. *Pimelodus menoda*, p. 203, pl. i, fig. 72.
15. *Pimelodus cavasius*, p. 203, pl. xi, fig. 67.
16. *Cyprinus (Chela) morar*, p. 264, pl. xxxi, fig. 75.
17. *Cyprinus (Barilius) cocsa*, p. 272, pl. iii, fig. 77.
18. *Cyprinus (Bangana) dero*, p. 277, pl. xxii, fig. 78.
19. *Cyprinus (Bangana) boga*, p. 286, pl. xxviii, fig. 80.
20. *Cyprinus (Cyprinus) curchius*, p. 289, pl. iv, fig. 82.
21. *Cyprinus (Cyprinus) nandina*, p. 300, pl. viii, fig. 84.
22. *Cyprinus (Morulius) morula*, p. 331, pl. xviii, fig. 91.
23. *Cobitis dario*, p. 354, pl. xxix, fig. 95.
24. *Cobitis geto*, p. 355, pl. xi, fig. 96.

Most of Buchanan's "original notes" are dated and from a perusal of these dates I had concluded (1929, p. 172) that Buchanan had used at least 15 illustrations in his "Fishes of the Ganges", which were made during the Survey period at the Government expense. My conjecture concerning these 15 species was correct and we now know for certain that there are 9 other species which should be included in this list.

List of species described or mentioned in the manuscript, with their vernacular names and references to published account in the "Gangetic Fishes", etc.

Serial No.	Specific name as given in MS.	Local name as given in MS.	Name under which described in "Gangetic Fishes".	Reference to drawings of species not published by Buchanan.
1.	*Tetrodon pulvinatus* B.	*Gang Potoca* Beng.	*Tetrodon fluviatilis*, p. 6, pl. xxx, fig. 1.	
2.	„ *laevis* B.	*Cutcutia* and *Pocoria potoca* Beng.	„ *cutcutia*, p. 8, pl. xviii, fig. 3.	
3.	„ *fornicatum* B.	*Boro potoca* Beng.	„ *potoca*, p. 7, pl. xviii, fig. 2.	
4.	*Muraena apterigia* B.	*Cuchia* Beng.	*Unibranchapertura cuchia*, p. 16, pl. xvi, fig. 4.	
5.	*Ophidium punctatum* B.	*Pancal* Beng.	*Macrognathus pancalus*, p. 30, pl. xxii, fig. 7.	
6.	„ *aculeatum* Bloch.	*Tara baïm* Beng.	„ *aculeatus*, p. 29.	Hora, pl. xiv, fig. 4.
7.	„ *simack* Walb.	*Baïm* Beng.	„ *armatus*, p. 28, pl. xxxvii, fig. 6.	
8.	*Gobius Eleotris* Lin. ?	*Pucoria balia* Beng.	*Gobius giuris*, p. 51, pl. xxxiii, fig. 15.	
9.	„ *pectenirostris* Walb. ?	*Dans* Beng.	„ *plinianus*, p. 45, pl. xxxv, fig. 13.	
10.	„ *novemradiatus* B.	*Dans* Beng.	„ *novemradiatus*, p. 47, pl. ii, fig. 14.	
11.	„ *Boddarti* Walb. ?	*Chaïngua* Beng.	„ *viridis*, p. 42, pl. xxxii, fig. 12.	
12.	„ *subunitus* B.	*Chaïngua* Beng.	„ *changua* p. 41, pl. v, fig. 11.	

Serial No.	Specific name as given in MS.	Local name as given in MS.	Name under which described in "Gangetic Fishes".	Reference to drawings of species not published by Buchanan.
13.	*Gobius bidentatus* B.	*Baeto chaĭngua* and *Guli chaĭngua* Beng.	*Gobius bato*, p. 40, pl. xxxvii, fig. 10.	
14.	,, *anguillaris* Lin. ?	*Lal chaĭngua* Beng.	*Gobioides rubicundus*, p. 37, pl. v, fig. 9.	
15.	*Pleuronectes trichodactylus* Lin. ?	*Charcuti*, *Mairoa* and *Carul putta* Beng.	*Pleuronectes pan*, p. 130, pl. xxiv, fig. 42.	
16.	*Zeus oblongus* B.	*Chanda* Beng.	*Chanda nama*, p. 109, pl. xxxix, fig. 37.	
17.	,, *Nalua* B.	*Nalua chanda* Beng.	,, *nalua*, p. 107, pl. vi, fig. 36.	
18.	,, *percoides* B.	*Chuna chanda* Beng.	,, *ranga*, p. 113, pl. xvi, fig. 38.	
	,, ,, var. *auratus* B.			
19.	,, *argenteus* B.	*Gang chanda* Beng.	,, *ruconius*, p. 106, pl. xii, fig. 35.	
20.	*Chaetodon ? lusua* B.	*Lusua* Beng.	*Coius chatareus*, p. 101, pl. xiv, fig. 34.	
21.	,, *argus* L.	*Pairatali*, *Rup chanda* and *Chitra* Beng.	*Chaetodon pairatalius*, p. 122, pl. xiv, fig. 41.	
22.	*Sparus melagaster* B.	*Culi* Beng.	*Cheilodipterus culius*, p. 55, pl. v. fig. 16.	
23.	,, *vagabundus* B.	*Gaichua* and *Chaing* Beng.	*Ophiocephalus gachua*, p. 68, pl. xxi, fig. 21.	
24.	,, *emarginatus* B.	*Lata* (adult) and *Goraĭ* (young) Beng.	,, *lata*, p. 63, pl. xxxiv, fig. 18.	
25.	,, *spilotus* B.	*Gozal* and *Sal* Beng.	,, *marulius*, p. 65, pl. xvii, fig. 19.	

Serial No.	Specific name as given in MS.	Local name as given in MS.	Name under which described in "Gangetic Fishes".	Reference to drawings of species not published by Buchanan.
26.	*Perca sparoides* B.	*Baidi* Beng.	*Labris badis*, p. 70, pl. xxv, fig. 23.	
27.	,, *nebulosa* B.	*Baida* and *Nandoz* Beng.	*Coius nandus*, p. 96, pl. xxx, fig. 32.	
28.	,, *setacea* B.	*Colescia* Beng.	*Trichopodus colisa*, p. 117, pl. xv, fig. 40.	
29.	,, *vagabunda* B.	*Coï* and *Cobozi* Beng.	*Coius cobojius*, p. 98, pl. xiii, fig. 33.	
30.	,, *bifurca* B.	*Polota*, *Naica* and *Gang Coi* Beng.	,, *polota*, p. 95, pl. xxxviii, fig. 31.	
31.	*Perca Datnia* B.	*Datnia*, *Polota* and *Gang Coï* Beng.	,, *datnia*, p. 88, pl. ix, fig. 29.	
32.	,, *Catcoïs* B.	*Catcoï* Beng.	,, *catus*, p. 90, pl. xxxviii, fig. 30.	
33.	,, *nilotica* Lin. ?	*Vecti* and *Vetci* Beng. *Cockup* English.	,, *vacti*, p. 86, pl. xvi, fig. 28.	
34.	,, *Cuja* B.	*Cuja Vecti* and *Coro Vecti* Beng.	*Bola cuja*, p. 81, pl. xii, fig. 27.	
35.	,, *Chaptis* B.	*Chapti Bola* Beng.	,, *chaptis*, p. 77, pl. x, fig. 25.	
36.	,, *Pama* B.	*Pama Bola* Beng. *Whiting* English.	,, *pama*, p. 78, pl. xxxii, fig. 26.	
37.	,, *Catoa* B.	*Cato Bola* and *Coïtur Bola* Beng.	,, *coitor*, p. 75, pl. xxvii, fig. 24.	
38.	*Cobitis Taenia* L.	*Butringy* and *Gunti* Beng.	*Cobitis guntea*, p. 353.	McClelland, pl. li, fig. 3.
39.	*Silurus tonsus* B.	*Silun* Beng.	*Pimelodus silonda*, p. 160, pl. vii, fig. 51 (50).	
40.	*Silurus sagittatus* B.	*Pungas* Beng.	,, *pangasius*, p. 163, pl. xxxiii, fig. 52.	
41.	,, *acanthias* B.	*Rita* Beng.	,, *rita*, p. 165, pls. xxiv and xxv, fig. 53.	

Serial No.	Specific name as given in MS.	Local name as given in MS.	Name under which described in "Gangetic Fishes".	Reference to drawings of species not published by Buchanan.
42.	*Silurus ascita* Lin.	*Gagora Taingra* Beng.	*Pimelodus gagora*, p. 167, pl. x, fig. 54.	
43.	,, *porosus* B.	*Guli* and *Nuna Taingra* Beng.	,, *gulio*, p. 201, pl. xxiii, fig. 66.	
44.	,, *quadrivittatus* B.	*Taingra* Beng.	,, *tengara*, p. 183, pl. iii, fig. 61.	
45.	,, *pictus* B.	*Aungi* Beng.	,, *angius*, p. 180, pl. xxix, fig. 59.	
46.	,, *acutus* B.	*Tunti* and *Caingun* Beng.	,, *vacha*, p. 196, pl. xix, fig. 64.	
47.	,, *sexcarinatus* B.	*Cainpagori* and *Goingra* Beng.	,, *gagata*, p. 197, pl. xxxix, fig. 65.	
48.	,, *tegrinus* B.	*Bag Ari* Beng.	,, *bagarius*, p. 186, pl. vii, fig. 62.	
49.	,, *Clarias* Lin. ?	*Ciunci Ari* and *Aor* Beng.	,, *aor*, p. 205, pl. xx, fig. 68.	
50.	,, *unitus* B.	*Cani Magur* Beng.	*Plotosus canius*, p. 142, pl. xv, fig. 44.	
51.	,, *Batrachus* Lin.	*Magur* and *Jagur* Beng.	*Macropteronotus magur*, p. 146, pl. xxvi, fig. 45.	
52.	,, *pungentispinus* B.	*Singi* Beng.	*Silurus singio*, p. 147, pl. xxxvii, fig. 46.	
53.	,, *Asotus* Lin. ?	*Pabda* Beng.	,, (*Callichrous*) *pabda*, p. 150, pl. xxv, fig. 47.	
54.	,, *pelorius* B.	*Boali* Beng.	,, ,, *boalis*, p. 154, pl. xxix, fig. 49.	

Serial No.	Specific name as given in MS.	Local name as given in MS.	Name under which described in "Gangetic Fishes".	Reference to drawings of species not published by Buchanan.
55.	*Silurus cultratus* B.	*Garua* Beng.	*Silurus* (*Callichrous*) *garua*, p. 156, pl. xxi, fig. 50.	
56.	*Esox ventricosus* B.	*Choe Puni* Beng.	*Esox panchax*, p. 211, pl. iii, fig. 69.	
57.	,, *scolopax* B.	*Cankila* Beng.	,, *cancila*, p. 213, pl. xxvii, fig. 70.	
58.	*Mugil protuberans* B.	*Corsula* Beng.	*Mugil corsula*, p. 221, pl. ix, fig. 97.	
59.	,, *latus* B.	*Parscia* and *Paidea* Beng.	,, *parsia*, p. 215, pl. xvii, fig. 71.	
60.	*Clupea cyprinoides* Broussoneti.	*Ciundona* and *Amolot* Beng.	*Cyprinodon cundinga*, p. 254.	Hora, pl. xviii, fig. 4.
61.	,, *fornicata* B.	*Chanpoli* and *Coara* Beng.	*Clupanodon chanpole*, p. 249, pl. xviii, fig. 74.	
62.	,, *Alosa* Lin. ?	*Holis* (adult) Beng.; *Hilsa* Hind.; *Sable Fish* English and *Coira* (young) Beng.	,, *ilisha*, p. 243, pl. xix, figs. 73 (75).	
63.	,, *cultrata* B.	*Chaila* Beng.	*Cyprinus* (*Chela*) *bacaila*, p. 265, pl. viii, fig. 76.	
64.	,, *ensiformis* B.	*Paisa* Beng.	*Clupea purava*, p. 238.	Hora, pl. xvii, fig. 3.
65.	,, *truncata* B.	*Gang paisa* Beng.	,, *telara*, p. 241, pl ii, fig. 72.	
66.	,, *didactyla* B.	*Poloï* Beng.	*Mystus kapirat*, p. 235.	Hora, pl. xxiii, fig. 1.
67.	*Cyprinus barbiger* B.	*Dana* and *Danicona* Beng.	*Cyprinus* (*Danio*) *danrica*, p. 325, pl. xvi, fig. 88.	
68.	,, *denticulatus* B.	*Ruhit* Beng.	*Cyprinus* (*Cyprinus*) *rohita*, p. 301, pl. xxxvi, fig. 85.	
69.	,, *atratus* B.	*Calbans* and *Calcuni* Beng.	,, ,, *calbasu*, p. 297, pl. ii, fig. 83 (33).	
70.	,, *rugosus* B.	*Soron Punti* Beng.	,, ,, *sarana*, p. 307.	Hora, pl. xxiii, fig. 5.

Serial No.	Specific name as given in MS.	Local name as given in MS.	Name under which described in "Gangetic Fishes".	Reference to drawings of species not published by Buchanan.
71.	*Cyprinus chrysopareius* B.	*Punti* Beng.; *Sophori* Sanskrit.	*Cyprinus* (*Puntius*) *sophore*, p. 310, pl. xix, fig. 86.	
72.	,, *bimaculatus* B.	*Tit Punti* Beng.; *Ticto Sophori* Sanskrit.	,, ,, *ticto*, p. 314, pl. viii, fig. 87.	
73.	,, *niloticus* Lin. ?	*Catla* Beng.	,, (*Cyprinus*) *catla*, p. 287, pl. xiii, fig. 81.	
74.	,, *bivittatus* B.	*Boro Daniconi* Beng.	,, (*Danio*) *daniconius*, p. 327, pl. xv, fig. 89.	
75.	,, *marginatus* B.	*Rasbora* Beng.	,, ,, *rasbora*, p. 329, pl. ii, fig. 90.	
76.	,, *bilineatus* B.	*Mourola*, *Cancuci* and *Tai* Beng.	,, (*Cabdio*) *mola*, p. 334, pl. xxxviii, fig. 92.	
77.	,, *trapezoides* B.	*Boeri* and *Amciuta* Beng.	,, ,, *cotio*, p. 339, pl. xxxix, fig. 93.	
78.	,, 18-*radiatus*	*Bansrata* Beng.	,, ,, *devario*, p. 341, pl. vi, fig. 94.	
37.†	*Polynemus paradiseus* L.	*Litsua* and *Rissua* Beng.; *Topissa* Hind. and *Mango Fish* English.	*Polynemus risua*, p. 228.	
4.†	*Muraena serpens*		Not described, pl. v, fig. 5.	
59+2.	*Mugil laevis*		*Mugil albula* ?, p. 218.	Hora, pl. xxii, fig. 1.
59+3.	,, *bangon*		,, *cephalus* ?, p. 219.	
79.	*Cyprinus gunea*		*Cyprinus* (*Cyprinus*) *gonius*, p. 292.	A.S.B. drawing IV, 123 missing.
80.	,, *curabatta*		,, (*Bangana*) *reba*, p. 280.	McClelland, pl. lviii, fig. 1.
81.	,, *mugul*		,, ,, *mrigala*, p. 279, pl. vi, fig. 79.	

Issued February 8th, 1933.

Reprinted from "Current Science," Vol. I, No. 3, September 1932.

Waterfalls as Habitats of Animals.*

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IN an earlier paper (1) the animals of the bed of a rapid flowing, shallow, rocky stream were divided into two "sub-associations" and each of these was again divided into three "strata". Further work on the ecology of the torrential streams has made it clear that the habitats should be classified into still finer divisions in order to realize the full significance of animal adaptations, *e.g.*, the correlation of an animal organization with its habitat. So long as the varying gradations in a particular environment are not thoroughly understood, the finer adjustments of the animals to their respective external conditions cannot be grasped. It has already been indicated (2) that a portion of a small stream can be classified according to the strength of the current and the nature of the substratum. It was then pointed out that the animal associations vary in accordance with the nature of these factors in an apparently similar environment. Following this line of research I have now subjected waterfalls to an intensive study, and have been greatly struck by the diverse associations of animals that inhabit this perilous situation. By a waterfall I do not mean only the spout of water that falls, but I include in it the vertical cliff of rock, the black pool at its base and the neighbouring parts of the gorge that receive a spray from the waterfalls. Thus defined, a waterfall can usually be divided into the following possible habitats of animals:—

1. Water spout.
2. Lip of waterfall.
3. Vertical rock behind the spout and not directly influenced by the current.
4. Usually habitat 3 is replaced by a slanting or vertical rock over which the water flows.
5. Rocks at the base of waterfall over which water crashes.
6. Rocks at the edge of the current intermittently splashed with the eddies of the turbulent waters.
7. Rocks in the neighbourhood of waterfalls which receive a constant spray of water.
8. Deep pool at the base of waterfall.

Even a casual consideration of this classification will show that the conditions of life in different situations must be different, and consequently, the association of animals inhabiting each division must also be different. It may, however, be indicated that there are no hard and fast limits, and that where the habitats grade into one another, the animal association also overlap one another. I shall now define the possible divisions of waterfalls in terms of ecological factors.

The waterspout lacks solid substratum and in the column of falling water there are no permanent inhabitants, but occasionally fish, such as salmon, mahseer, etc., when ascending streams for the purpose of spawning leap through waterfalls. Large waterfalls or cataracts, however, form effective barriers for the ascent of even these muscular fishes.

The existence of animals on the lips of waterfalls must seem very precarious. It has, however, been shown (1) that the lips of waterfalls can be divided into two categories ecologically, those in which the rocks are covered with vegetation and those in which the rocks are bare. Vegetation, besides affording shelter, provides a secure substratum which enables animals to cling to it by means of hooking devices. On a bare rock much firmer grip is required for stability of movement, and consequently the fauna is relatively poorer. Blepharocerid larvæ (Diptera) and nymphs of *Ir*

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A short account of waterfalls as habitats of animals is given by Pearse in *Animal Ecology*, p. 194, New York, 1926.

and *Baetis* (Ephemeroptera) are found on bare rocks, while among vegation the fauna is much richer and varied, and mainly consists of the torpedo-shaped clinging larvæ of Diptera, Plecoptera and Ephemeroptera. According to the strength of the current, the fauna varies considerably in this habitat.

The vertical face of rock behind the column of falling water, but not affected by it, is a place of safety for several kinds of insects, watermites and other small animals. The mosses that grow in this situation afford protection and substratum for anchorage to a number of small organisms. There are certain species of birds that make nests in this habitat. The fauna here varies with the amount of moisture available, and if there is a regular flow of water over the rock (as in habitat 4), fishes may be observed sucking their way up the cliff.

Sometimes the falling column of water flows over smooth, slanting rocks and in such cases the nature of the fauna depends upon the rapidity of the current. If the current is not very fast Caddis-worms of several types are found, but in swift waters ...pharocerid and *Simulium* (Diptera) larvæ abound. Fishes, such as *Garra*, and tadpoles, as those of *Rana afghana*, are also found climbing upstream in this habitat.

The animals that live at the base of a waterfall must be able to withstand a tremendous crash of water. I have collected chiton-like larvæ of the Blepharoceridæ at the base of small falls. It is presumed that the chiton-shape of these larvæ enables them to take the firmest possible hold. The only other animals that were found in this situation were the pupæ of Caddis-flies, but they occurred on the sides of stones and not on their upper surfaces over which the water fell. According to Dodds (3), the nymphs of *Bœtis bicaudatus* live on rocks where water pours upon them with considerable force.

The rocks in the immediate neighbourhood of the current constitute a very important habitat in this environment, for they afford places of safety for the pupæ of insects and also provide substratum to the adults for egg-laying. In this situation the animals are less liable to be swept away by the current, though they are kept moist by an intermittent splashing or by the dribbling of water from the lip of a waterfall. From here the larvæ migrate into swifter waters, and the pupæ can let out the adults in ...mparative safety.

The rocks at a little distance away from the waterfall are kept moist by a spray. A large number of moisture-loving animals live in this habitat, but the most striking are the larvæ and pupæ of Psychodidæ which were very common in streams round about Tista Bridge below Darjeeling. These insects live on bare rocks and their earlier stages resemble those of the Blepharoceridæ superficially. Some interesting Copepods have been collected from among mosses. The fauna varies according to the nature of the substratum in this habitat.

The fauna of a pool at the base of a waterfall is very different. The water does not flow very rapidly in it, but it is highly oxygenated. Migratory and other fishes are found in it. Frogs, insects and their larvæ, leeches, molluscs, etc., are all found in these pools.

From the above it is clear that the habitats of animals are as specific as the characters of the species, and probably equally difficult to define. Though our knowledge of the classification of animals has made great progress, unfortunately our knowledge of their habits and habitats is very meagre. It is generally conceded at the present time that "Structural modifications shown to be adapted to particular habitats or modes of life seem to be more characteristic of genera or groups of higher ranks than of species" (4). Generally speaking, the factors strength of current, nature of substratum, amount of moisture, etc., used above for classifying waterfalls, influence groups of animals and mould them to similar lines. Possibly the finer gradations of these factors distinguish species. As an illustration we may take the three species of *Bœtis* described by Dodds (3 & 5) from Colorado living on rocks in swift currents. *B. tricaudatus* with three caudal cerci lives in currents flowing at the rate of 5 feet per second. *B. intermedius* in which the middle caudal cercus is decidedly shorter, lives in waters flowing as much as 8 feet per second and finally *B. bicaudatus*, in which the middle cercus is represented by a vestige only, lives in places where the water flows at the rate of 10 feet per second.

The reduction of the middle cercus (as well as the modification in the shape of the posterior part of the body) can thus be correlated with the increased swiftness of the current and the modification is useful in imparting to the animal perfect stream lines. It is clear, therefore, that minute differences

between species, when studied ecologically, can be correlated with the *intensities* of certain factors in their environments.

The study of Animal Ecology is growing in importance, and it is reasonable to expect that some international standards of the classification of habitats and of nomenclature will be fixed before long to save the new branch of science from the fate that has overtaken Taxonomy.

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Reprinted from "Current Science," Vol. I, No. 5, November 1932, page 130.

A Siluroid Fish from Afghanistan.

Glyptosternum reticulatum McClelland.

Glyptosternum reticulatum was briefly and inadequately described by McClelland in 1842[1] from Sir-i-Chusma, the source of the Kabul River, and since then it has caused considerable confusion in the toxonomy of certain Sisorid fishes. In the August issue of the *Annals and Magazine of Natural History* evidence was adduced to show that *G. reticulatum* is identical with the well-known and widely distributed species "*Parexostoma stoliczkæ* (Day)" and that *Parexostoma* Regan is a synonym of *Glyptosternum* McClelland. These conclusions were based on an examination of abundant material collected by my colleague Dr. B. N. Chopra in the Chitral Valley, from which waters drain into the Kabul River.

Through the courtesy of the Bombay Natural History Society I have received a small collection of fish, comprising 4 specimens, made during August last in the Paghman River, a tributary of the Kabul River, by the Legation Surgeon to the British Legation at Kabul. In this lot there is a well-preserved specimen of *G. reticulatum*, the study of which leaves no doubt whatsoever of the identity of McCleiland's much-discussed species with *P. stoliczkæ*, and in consequence changes will have to be made in the nomenclature of these, as well as in the closely allied Sisorid fishes.

SUNDER LAL HORA.

Zoological Survey of India,
Indian Museum, Calcutta,
October 22, 1932.

[1] *Calcutta Journ. Nat. Hist.*, **2**, 584.

ꜞIOLOGICAL NOTES ON A FISH FROM BRAZIL IN THE SOCIETY'S AQUARIUM. By SUNDER LAL HORA, D.Sc., F.R.S.E., F.Z.S.

[*From the* Proceedings of the Zoological Society of London, 1932.]
[Published March 30th, 1932.]

[*Reprinted from* PROC. ZOOL. SOC. *Part* 1, 1932.]

Biological Notes on a Fish from Brazil in the Society's Aquarium.

By SUNDER LAL HORA, D.Sc., F.R.S.E., F.Z.S., Zoological Survey of India, Calcutta.

(Offered for Publication by permission of the Director, Zoological Survey of India.)

During a visit to the Aquarium of the Zoological Society of London towards the end of August 1931 I noticed an exhibit of two specimens of a Loricariid fish, labelled *Plecostomus commersoni*. The Loricariidæ are mostly found in the fast-running waters of South America, where they stick to rocks by means of their characteristic inferior sucker-like mouth. It has been assumed that when these fishes fasten themselves to stones by means of the sucker-like mouth the respiration is then effected " by taking in water through the gill-openings and expelling it again by the same passage in a reverse direction "*. I have observed, however, that in the torrent-inhabiting fishes of India †, such as *Garra*, *Glyptothorax*, *Pseudecheneis*, and *Balitora*, the respiration takes place in the normal way—the rhythmical suction of water into the oral cavity and its consequent expulsion through the gill-openings. Though *Pseudecheneis*, and to a certain extent *Glyptothorax*, possess the type of suctorial mouth so characteristic of the Loricariidæ, it was difficult to say, in the absence of any observations on the living specimens, whether the method of respiration in the Loricariidæ is normal or of the type assumed from the position of its mouth and the structure of its lips. In order to settle this point I decided to make observations on the two specimens in the Society's Aquarium.

At my request the specimens in the Aquarium were placed at my disposal by Mr. E. G. Boulenger, Director of the Aquarium, for making observations, and for this my best thanks are due to him. He also provided me with the necessary apparatus and allowed me the use of the small laboratory in the Aquarium. The observations detailed below were made on the 15th and 16th September, 1931. The morphological details were studied later in specimens preserved in the British Museum (Natural History).

I have to point out that the specimens in the Aquarium belong to the genus *Loricaria*, and not to *Plecostomus*. It was not possible to identify them specifically, as the specific distinctions could not be studied in the living specimens.

As indicated above, my special object was to study the method of respiration, and for this purpose the following simple apparatus was designed. A mirror of a sufficiently large size (12″×15″) was placed on a working table. On two opposite sides of the mirror two bricks were placed. A rectangular piece of glass was then placed on the bricks covering the mirror below. On this glass a rectangular dish was kept. At the time of making observations the fish were transferred to the dish. (The dish selected should be smaller than the distance between the two bricks, so that every part of the dish can be reflected in the mirror below.)

* Regan, Trans. Zool. Soc. London, xvii. p. 191 (1904).

† Hora, Rec. Ind. Mus. xxv. pp. 591–596 (1923).

When placed in the dish the fishes adhered to the bottom, so that their mouths and associated parts could be watched in the mirror. For making observations on the respiration of the fish a solution of carmine powder in water was used. A small cloud of this solution was floated quite close to and partly below the snout of the fish, and it was then noticed that the fish inhaled the red particles of carmine through the mouth, and a stream of the solution was seen coming out through the gill-openings. This showed that the respiration is effected in the normal way in *Loricaria*. A cloud of carmine kept near the gill-opening was not inhaled, but gradually drifted away from the fish. When the head of the fish was pressed against the substratum by hand the respiratory movements of the mouth stopped altogether. Even in these circumstances water was not taken in through the gill-openings. The full details of the observations made are as follows:—

When transferred to the dish the fish lay quietly at the bottom and breathed hurriedly for a short time, but after a few minutes the respiratory movements slowed down and became apparently normal. It was then observed that as the fish lay closely applied to the substratum a gentle current of water was sucked in through the mouth and passed out of the gill-openings. This normal mode of breathing was so gentle that somewhat larger particles of the carmine powder near the mouth were hardly disturbed from their positions. The circular opening of the mouth was guarded by a velum-like membrane that could be stretched across it to close it entirely. Under normal conditions of respiration only a small portion of the membrane at the anterior end appeared to be moved backwards and forwards, and through the narrow passage thus formed water was sucked in. The movements of the membrane could be easily watched and counted from above, as the reflected light from the mirror showed through the roof of the buccal cavity when the membrane was moved to and fro. Of the two specimens one was more active and behaved differently from the other. After every two or three normal breaths it took in a deep breath, which was marked by the raising of the dorsal fin and the tail and also by a slight quivering movement of the posterior rays of the paired fins. Normally it took about ninety-two breaths in a minute, of which about thirty were deep breaths. When the fish was touched with some object it did not move off, but showed its excitement by taking in large gulps of water. When the head of the fish was pressed against the substratum it stretched the membrane across the mouth and stopped breathing altogether, without showing any marked uneasiness; but soon after the pressure was released, after a minute or two, the fish darted quickly to another part of the dish, almost "panting." In nature the fish probably suspends respiration to tide over heavy floods.

The gill-opening shows some interesting modifications, and can be divided into two parts both morphologically as well as physiologically. It is small and extends obliquely in front of the base of the pectoral fin. In the part of the opening above the base of the fin the operculum is not provided with a loose membranous flap at its posterior end, and fits very closely against the bones of the pectoral girdle. I have observed that this portion of the gill-opening takes no part in the respiratory movements of the fish. The remaining portion of the opening below the base of the pectoral fin is guarded by a broad flap of skin, and the clouds of carmine were exhaled through this part alone. The opening leads to a deep cavity in which the gills are situated.

In the case of the Indian hill-stream fishes it was observed that only a small upper part of the gill-opening functioned in the respiratory movements of the fish, whereas the lower part was either non-functional or was opened only at the time of a deep breath. In *Loricaria* exactly the reverse of this has taken place.

This is probably due to the method of fixation and progression in the two types of fishes. In *Balitora*, for instance, the pectoral fins are horizontally inserted and a number of the outer rays are closely applied to the substratum. In these circumstances the lower part of the gill-opening cannot function. In *Loricaria*, on the other hand, it was observed that the paired fins were held obliquely, with the distal part of the anteriormost ray touching the substratum. The carmine solution shot out through the gill-opening passed underneath the pectoral fin.

There can hardly be any doubt that in *Loricaria* the attachment to the substratum is effected by the lips and the spines of the pectoral, ventral, and anal fins. The plates on the ventral surface of the body also help in fixation. A fish as it lay at the bottom was held by the tail and moved forwards and backwards. It offered no resistance, but when I wanted to lift it vertically upwards it became restless and loosened its hold on the substratum. I am therefore unable to say whether the lips form a definite sucker or not. Under normal conditions, when breathing goes on, the lips cannot form a vacuum sucker, and fixation is then effected through adpression. The spinous papillæ on the lips and the prickles on the fin-spines, which are directed posteriorly, enable the fish to hold fast to the substratum. The fish crawls along the substratum by using its paired fins alternately and by holding to the substratum with the lips.

I was informed by Mr. Vinall, Overseer of the Aquarium, that the two specimens now in the Aquarium formed part of a lot of four specimens presented to the Zoological Society of London by Mr. L. W. Hawkins on 8th January, 1931. Of these one died on 27th June and another on 25th August. I was further informed that these fishes are fed thrice a week on *Daphnia* or scrapped heart. As in running water such a food would be an impossibility, I wanted to observe them feeding. The two specimens were transferred to the dish, and a meal of *Daphnia* was provided for them. Although the small crustaceans kicked about under the snout of the fish, no excitement whatsoever was shown by the fish. In nature I believe these fish feed on algal slime which they scrape off the rocks, or on small insect larvæ that stick on the rocks in fast currents. In the Aquarium I presume they would pick up food particles settled at the bottom by accidentally rolling over them. The eyes being small and dorsolateral in position could not assist in bottom-feeding, and the mouth being small and inferior could not be used for surface or mid-water feeding.

Reprinted from "Current Science," Vol. I, No. 12, June 1933, *page* 407.

Ecology of the Fauna of the Salt Range, Punjab

By Dr. Sunder Lal Hora, D.SC., F.A.S.B.

Ecology of the Fauna of the Salt Range, Punjab.

To the students of animal distribution and ecology the fauna of the Salt Range, Punjab, presents several features of great interest. For a number of years the animal life of this hot and dry tract, with peculiar conditions of the soil, was known from casual observations and collections made through the efforts of the earlier geologists Theobald and Waagen, in the course of their geological explorations. In 1922-23, however, the Zoological Survey of India made faunistic studies (*Rec. Ind. Mus.*, **25**, 365, 601 1923) of this region, and even then attention was mainly directed to the cold-blooded vertebrates and molluscs. It is a matter of great pleasure, therefore, that in the recent issue of the *Records of the Indian Museum* (pp. 87-119), Dr. H. S. Pruthi extends our knowledge of the aquatic animal life of this area by making "An Ecological Study of the Fauna of the Khewra Gorge and some other salt waters of the Salt Range, Punjab". He not only brings home to us the varied nature of the aquatic fauna, rich in insects, but also indicates, in a masterly way, the conditions of the peculiar environment to which the animals have become adjusted, evidently by a process of gradual colonization The physical and chemical factors of the environment are analysed, but unfortunately it is not indicated whether any structural modifications have resulted from the adaptation of animals to these very adverse conditions of existence. In concluding the article, Dr. Pruthi refers to the interesting question of the colonization of the sea by insects, and makes a tentative suggestion that, in all probability, the insufficiency of calcium is the inhibiting factor, for he found the insect-fauna very rich and varied in the waters of the Khewra Gorge which had a large amount of calcium in solution.

Even a cursory perusal of this interesting article shows the great range of adaptability to changes in salinity that is exhibited by the fauna, and also the plastic nature of the animals, which become moulded, presumbly in course of time, structurally (?) or at least physiologically to highly adverse conditions of existence. What was the nature of the impulse behind this colonization of wate: 4 to 5 times as salty as that of the sea Probably it was the search of new feedin grounds, or may be that these highly salin waters provided shelter from enemies. It will be of great interest to elucidate these interesting biological points.

S. L. H.

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXVII, 1931, No. 1.
Issued 8th February, 1933.

Further Notes on Hamilton-Buchanan's *Cyprinus chagunio*

By Sunder Lal Hora and D. D. Mukerji

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXVII, 1931, No. 1.

ARTICLE NO. 7.

Further Notes on Hamilton-Buchanan's *Cyprinus chagunio*.

By SUNDER LAL HORA *and* D. D. MUKERJI.

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In 1928, one[1] of us communicated to the Society a few remarks on Günther-Day controversy regarding the specific

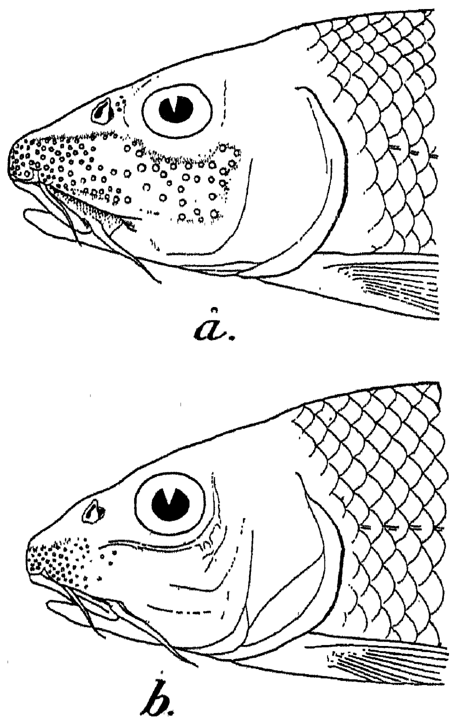


Fig. 1.—Lateral view of the head of a male (*a*) and a female (*b*) specimen of *Barbus chaguinio* (Ham. Buch.). Same size.
In the male the maxillary groove is seen as the mouth is more widely open.

validity of Hamilton-Buchanan's *Cyprinus chagunio*,[2] which was obtained by its author "in the Yamuna, and in the

[1] Hora, *Journ. Asiat. Soc. Bengal* (N.S.), XXIII, pp. 415-417 (1928).
[2] Buchanan, *Gangetic Fishes*, p. 295 (1822).

northern rivers of Behar and Bengal". It was indicated that Day was correct in associating the drawing labelled as "*Cyprinus kunta*" in the Society's collection (*A.S.B.*, I, 39; *Mem. Ind. Mus.*, IX, pl. xxi, fig. 7, 1929) with *Cyprinus chagunio* of the "Gangetic Fishes", and in relegating *Barbus beavani* Günther[1] to the synonymy of *B. chagunio.* Day[2] also regarded *B. spilopholus* McClelland[3] as a mere Assamese variety of *B. chagunio* and included it in the synonymy of Buchanan's species. Chaudhuri[4] refers to the whole controversy again in 1913, and redescribes *B. spilopholus* as a distinct

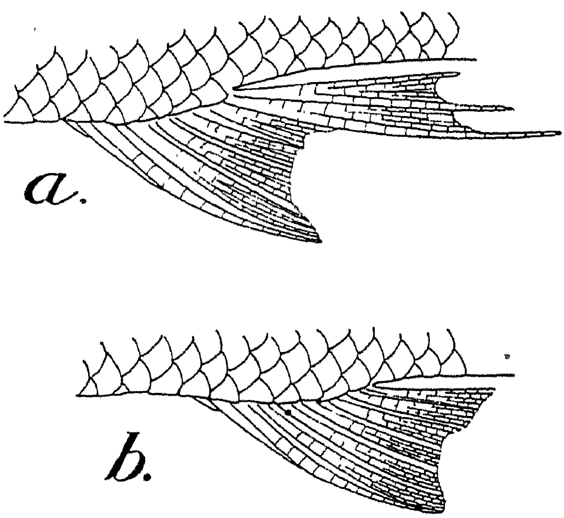


Fig. 2.—The structure of the anal fin of a male (*a*) and a female (*b*) specimen of *Barbus chagunio* (Ham. Buch.). ×1½.

and definite species from an excellent specimen obtained by Dr. S. W. Kemp in the Abor Hills, Assam. He further seems to suggest that *B. chagunio* (H.B.) still remains undetermined.

Messrs. G. E. Shaw and E. O. Shebbeare's collection of fish from streams below Darjiling contains 18 specimens, some of which correspond with *Barbus spilopholus*, whereas the others are indistinguishable from *B. chagunio*. The two forms are undoubtedly closely allied and the main difference between them consists in the elongation of a number of posterior rays in the anal fin of the former. Moreover, in *B. spilopholus* the raised tuberculated areas on the head are well-defined and

[1] Günther, *Cat. Fish. Brit. Mus.*, VII, p. 96 (1868).

[2] Day, *Fish. India*, p. 559, pl. cxxxvi, fig. 2 (1878).

[3] McClelland, *As. Res.* (Ind. Cyp.), XIX, pp. 272, 341, pl. xxxix, fig. 4 (1839).

[4] Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 250, pl. viii, figs. 1, 1*a*, 1*b* (1913).

compact, the black mark on the distal portions of some of the anterior rays of the dorsal fin is more prominent, and the body as a whole is more gorgeously coloured. In a number of fishes the elongated fin-rays, the gorgeous colouration and the tuberculated areas on the head are often associated with the males as forming secondary sexual characters. We dissected all the specimens with a view to determine the sexes of the individuals. There are four examples below 3·5 inches in length (*B. chagunio* is said to grow to a foot and a half in length both by Buchanan and by Day) in which the sex cannot be determined with certainty. Of the remaining fourteen individuals there are 6 males and 8 females.[1] All the male specimens possess the specific characters attributed to McClelland's *B. spilopholus*; whereas the females are referrable to *B. chagunio* of Buchanan. In view of what has been said above we have no hesitation in assigning both the forms to the same species—*B. chagunio* (H.B.). *Barbus chagunio* is a widely distributed fish of economic importance, and recently it has been found to occur in large numbers in the Myitkyina District of Upper Burma.[2]

Attention may also be directed to McClelland's remarks,[3] referred to by Chaudhuri (*op. cit.*), regarding the identity of *Cyprinus chagunio*. In describing *Barbus clavatus* from the rivers at the foot of the Sikkim Mountains he expressed the belief that his "large spined barbel" was identical with *B. chagunio*. This is not correct. These two species are abundantly distinct in their general build, in lepidosis and in the form and nature of the serrated dorsal spine. *B. clavatus* was insufficiently characterised and poorly illustrated by McClelland, and for a long time its specific limits could not be defined with precision. One[4] of us, however, obtained specimens of *B. clavatus* from the Naga Hills, Assam, redescribed it in 1921 and gave an illustration of the fish.

[1] It is likely that most of the immature specimens are females as they do not exhibit even the slightest indication of the external characters of the males. The total number of specimens examined (18) is too small to say anything regarding the probable Sex Ratio in this species; but the above figures suggest that the females predominate in nature. This is further shown by the fact that females (=*B. chagunio*) have been found and recorded by several workers, whereas the males (=*B. spilopholus*) are rare in the museum collections.

[2] Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, p. 195 (1929).

[3] McClelland, *Calcutta Journ. Nat. Hist.*, V, p. 279 (1845).

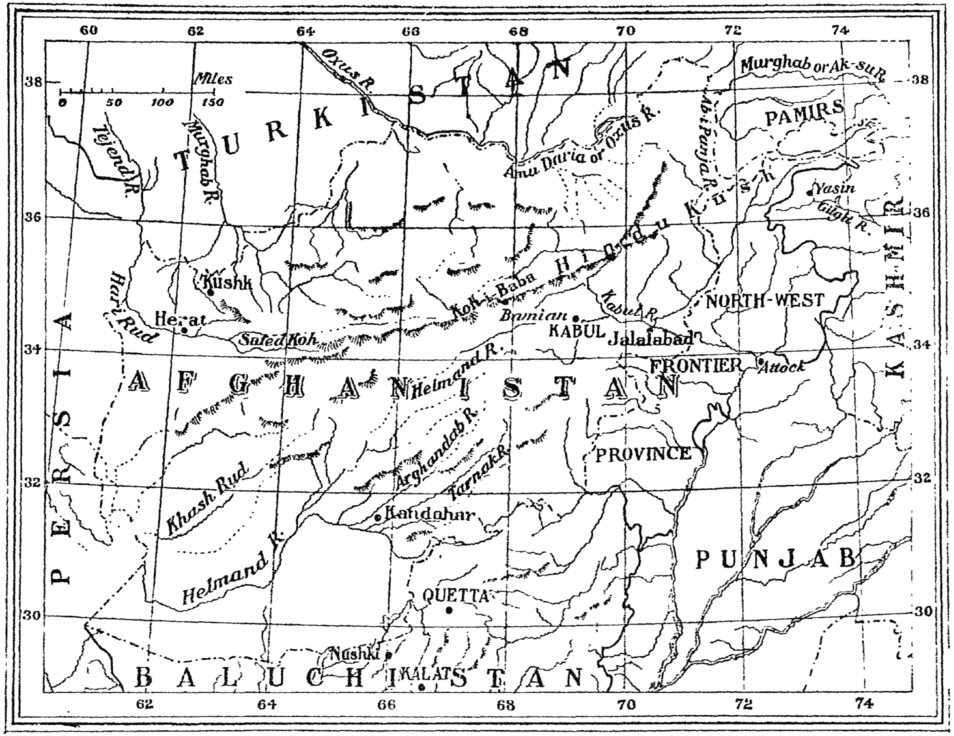
[4] Hora, *Rec. Ind. Mus.*, XXII, p. 185, pl. ix, fig. 1 (1921).

Issued February 8th, 1933.

EPRINTED FROM THE *Journal of the Bombay Natural History Society, Vol. XXXVI, No. 3, dated 15-8-193*

FISH OF AFGHANISTAN. BY SUNDER LAL HORA, D.SC., F.R.S.E., F.A.S.B

(With a map, a plate and 2 text-figures.)



AFGHANISTAN

Map of Afghanistan and the neighbouring country showing the position of the various places, rivers and mountains referred to in the text. Modified from the map in the *Imperial Gazetteer of India*, v, p. 64 (1908).

Note.—Broken line indicates the boundary of Afghanistan.

[*From the* JOURNAL OF THE BOMBAY NATURAL HIST. SOC., *August* 15, 1933.]

FISH OF AFGHANISTAN.

By Sunder Lal Hora, D.SC., F.R.S.E., F.A.S.B.,

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(*With a map, a plate and 2 text-figures*).

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CONTENTS

INTRODUCTION.

With the exception of inadequate and highly confusing descriptions of certain species collected by Griffith and reported by McClelland[1] in 1842, very little is known about the ichthyology of Afghanistan. It is a matter of great pleasure, therefore, to be in a position to report, after a lapse of about 90 years, on a collection of fishes from this region. This happy result is due to the persistent efforts of Mr. S. H. Prater, Curator of the Bombay Natural History Society, who, at my suggestion, interested the members of the British Embassy at the Court of Afghanistan to make a collection of fish in the Kabul River and the adjoining provinces. In 1931, a specimen of the trout, '*Salmo orientalis* McClelland', was received from Sir Richard Maconachie, and in September 1932 the Bombay Natural History Society received a fine lot of four specimens collected at Paghman in the Paghman River by the Military Attaché, British Legation, Kabul. The interest of these collections lies in the fact that they enable us to understand the systematic position and the specific limits of certain fish described by McClelland. Griffith made extensive collections and it is not likely, therefore, that many new forms will be discovered in Afghanistan, especially in the regions traversed by him. Unfortunately, a part of his collection was either lost or badly damaged in transit, and, consequently, the material in McClelland's hands was not very trustworthy and a number of new species were described from drawings only. It is to be regretted that McClelland's reproductions of these illustrations are very poor, and that the whereabouts of the originals is

[1] McClelland, *Calcutta Journ. Nat. Hist.*, II, pp. 575-586 (1842).

not known. Since Griffith's time the ichthyology of Central Asia has received considerable attention, and the names given by McClelland to Afghanistan fishes are being used for species known from widely separated localities. A very wide interpretation is being given to McClelland's species in view of the fact that, in most cases, his descriptions and figures have nothing specific about them, and that they are equally applicable to a number of species. The five specimens of fish received from Afghanistan have helped to clear up highly controversial points regarding the taxonomy and provenance of certain genera and species, and it is confidently to be hoped that further collections from Afghanistan will be made available before long for the proper understanding of the ichthyology of the country. I take this opportunity to extend my warmest thanks to all those who have put me in a position to report on the fish of Afghanistan, and to direct the attention of likely collectors to the nature of the material to be looked for and the localities that should be thoroughly investigated.

Physical Features of Afghanistan.

'Afghanistan is a long, oval-shaped country, stretching through 700 miles, narrowing to a point on the north-east, where an arm is extended outwards to the Pamirs. Right across it, from west to east (but curving upwards to touch this extended arm at its eastern extremity), is a band of mountains, which separates the basin of the Oxus on the north from that of the Indus and the Helmand on the south, but which still leaves space for a river (the Hari Rud, or River of Herat) to form a basin of its own on the north-west.'[1] Afghanistan lies between 29°23' and 38°31' N. and 60°45' and 72°0' E., with a long narrow strip extending to 74°55' E.; and its total area is estimated to be 246,000 square miles.

There are three main river basins in Afghanistan: namely, those of the Oxus, the Helmand, and the Kabul. 'With the Oxus basin may be included those of the Murghab and the Hari Rud, though neither of these rivers finds its way to the Oxus, both being lost in the great desert lying to the north-west of Afghanistan, the former near Merv and the latter in the Tejend Oasis.'[2]

'The Oxus basin occupies the whole breadth of Northern Afghanistan from east to west. With its affluents it drains the Western Pamirs; and its southern watershed is defined by the Hindu Kush; the Koh-i-Baba, and the Band-i-Baian, which separate it from the basins of the Kabul and Helmand.' The Oxus empties itself in the Aral Sea. 'The Helmand (*Etymander*) river with its tributaries, drains all the south-western portion of Afghanistan. It rises in the Western slopes of the Paghman range. between Kabul and Bamian, and flows in a south-westerly direction through the Hazarajat, being joined about 35 miles south-west of Girishk by three great tributaries, the Arghandab, the Tarnak, and the Arghastan. . . . The basin of Kabul river is

[1] Holdich, *Society of Arts Journal* of March 11, 1904.
[2] Clarke, *Imperial Gazetteer of India*, V, p. 29 (1908).

divided from that of Helmand by the Paghman range, an offshoot of the Hindu Kush. This river rises about 40 miles west of Kabul city, near the Unai pass, and flows in a general easterly direction to Dakka, where it turns northwards, forming a loop enclosing much of the Mohmand country. It then turns east and south again, and eventually joins the Indus at Attock'.

Historical Sketch.

In the years 1836-38, Lieut.-Col. Sir Alexander Burnes was sent on a mission to Kabul, and in the party that accompanied him Dr. P. B. Lord acted as Naturalist in addition to his other duties. In sending the mission, 'The objects of Government were to work out its policy of opening the river Indus to commerce, and establishing on its banks, and in the countries beyond it, such relations as should contribute to the desired end.'[1] In pursuance of this policy the mission went all the way up by river as far as Attock, thence to Peshawar and from there over the Khyber Pass to Kabul. During this journey drawings of animals were made and about '200 specimens of natural history' were collected. The drawings with a letterpress by Dr. Lord and the specimens were presented by the Supreme Government to the Asiatic Society of Bengal in September 1838, and it was once the intention of the Society to publish coloured lithographed copies of these zoological sketches. I have indicated elsewhere[2] how, after spending nearly six thousand rupees, the Society gave up its intention in 1847 by not issuing even the printed copies of these illustrations. A very careful search of the rooms of the Society has not revealed the existence of any published copies of this work.

In Burnes' collection of drawings there are illustrations of 32 species of fish, but only two of these are stated to have been collected in the Kabul River. Of these two, one is said to be common to 'River of Cabool and Attock'. Unfortunately the precise locality of these two species is not indicated, though in nearly all other cases the names of towns are mentioned. It is not certain, therefore, whether any fish was collected in Afghanistan or not, as the species stated to have been collected in the Kabul River may have been obtained outside the geographical limits of that country. As many as 29 species of fish figured in this collection are those that are commonly found in the plains of India, while *Oreinus sinuatus*, (probably *O. plagiostomus*, pl. vi MS), *Schizothorax labiatus* (pl. vii MS) and *Schizothorax esocinus* (pl. vii Ms) are typically Central Asiatic forms, which are known to occur in the Kabul River and its tributaries much higher up. It is interesting to note that both the species of *Schizothorax* are said to have been found at Attock. According

[1] Burnes, *Cabool* (London: 1842).

[2] Hora, *Journ. As. Soc. Bengal* (n.s.), xxii, pp. 117-125 (1926).

to Burnes the rivers of Afghanistan are 'well stored with fish' and Ghoorbund, Purwan and Punjsheer, are rapid brooks with stony beds. In winter they can be easily forded, while in spring and summer they are much swollen. These streams unite and 20 miles from Kabul near Tungi Gharoi there is a waterfall. 'It is one of the great amusements of the people to ensnare the fish as they leap up this cascade.'[1] Afghans, as a rule, are not good collectors of zoological specimens, and fish, of which their rivers are said to be heavily stocked, does not form an important article of their diet.

The ichthyology of Afghanistan was made known for the first time through the researches of Mr. William Griffith, who seems to have possessed a considerable knowledge of the freshwater fishes of India. Griffith entered Afghanistan through the Bolan pass and studied the fishes of the Helmand system, and from there he went to the Oxus system on the northern slope of the Hindu Kush. The fishes of the Kabul River were next investigated and then on his way back to India he studied the fish of the streams in the Khyber Pass. It is thus seen that Griffith made collections in all the three principal river systems of Afghanistan. Griffith's own remarks on these collections are included in the introductory part of McClelland's account, and they give a very good general idea of the fish-fauna of Afghanistan. A perusal of this account leaves an impression that there are many species of fish, which were observed by Griffith but have not been reported by McClelland probably through lack of material. In all McClelland records 20 species of fish from Afghanistan, of which 5 represent the Indian element in the fauna, the remaining 15 being typically Central Asiatic. Of these 15 species, 2 occur in the Oxus basin, 5 in the Helmand basin and as many as 11 in the Kabul basin. These species may be listed below as follows:—

Oxus System.

1. *Racoma gobiodies* McClell.	Bamean River.
2. *Salmo orientalis* McClell.	Northern declivities of the Hindu Kush, and Bamean River.

Helmand System.

1. *Racoma brevis* McClell.	Helmand River.
2. *Schizothorax esocinus* Heck.	Tributaries of the Helmand and Kabul rivers.
3. *Schizothorax intermedius* McClell.	Tarnak River and Kabul River at Jalalabad.
4. *Schizothorax ritchieana* McClell.	A variety with the small dorsal spine in the Helmand River.
5. *Orcinus plagiostomus* Heck.	Helmand River at Girdun Dewar.

[1] Burnes, *Cabool*, p. 154 (London: 1842).

Kabul System.

a. Central Asiatic forms.

1. *Racoma chrysochloa* McClell.	'Lolpore'.
2. *Racoma nobilis* McClell.	
3. *Racoma labiatus* McClell.	Pashat, Kunar River.
4. *Schizothorax esocinus* McClell.	Tributaries of the Helmand and the Kabul rivers.
5. *Schizothorax intermedius* McClell.	Kabul River at Jalalabad and Tarnak River.
6. *Schizothorax edeniana* McClell.	Koti-i-Ashraf, Mydan Valley and Sir-i-Chushmah.
7. *Schizothorax ritchieana* McClell.	Afghanistan. A variety in the Helmand.
8. *Schizothorax barbatus* McClell.	Jalalabad.
9. *Orcinus maculatus* McClell.	Gandamak, Khyber Pass, Himalaya.
10. *Orcinus griffithii* McClell.	Pashat, Kunar River.
11. *Glyptosternum reticulatum* McClell.	Sir-i-Chushmah, Kabul River.

b. Species allied to Indian fauna.

1. *Cirrhinus burnesiana* McClell.	Jalalabad.
2. *Opsarus bicirratus* McClell.	Jalalabad, Khyber Pass.
3. *Ophiocephalus montanus* McClell.	'Baisoot, Jalalabad, Himalaya and Sadoo.'
4. *Silurus indicus* McClell.	'Loodianah, the Punjab, and the Cabool river at Jalalabad.'
5. *Pimelodus anisurus* McClell.	'Loodianah and Cabool river at Jalalabad.'

In the above list the names given by McClelland to the various species are used, and till we become more familiar with the Afghanistan fishes it may be advisable to refer to the species by these names. The above list shows that there are 3 species that are common to the Kabul and the Helmand river systems. The sources of these rivers are not very far apart, and it is not unlikely, therefore, that several other common species may be discovered later on. The second point of interest is that Jalalabad forms the furthest limit to the north-west to which the species of India extend. We have already seen from Burnes' collection of drawings that Attock is the limit to which the Central Asiatic species of the Kabul River extend downwards to the south-east.

In 1880, Day[1] wrote an article on the 'Fishes of Afghanistan', but a perusal of the paper shows that his material was collected in the highland of Kelat and Quetta, and from Gwadur on the Mekran coast. These places once formed part of Afghanistan, but are now included in Baluchistan. Day's account applies to the fish of 'a range of hills stretching from the valley of the Indus, their utmost southern point being near Kurrachee; and in their course they divide Sind from Baluchistan.' As is to be expected, the major portion of the fish-fauna of this tract is similar to the Indian fauna. The genus *Scaphiodon* is characteristic of Baluchistan, though one species is found in the Salt Range,[2] Punjab, and three others in the Nilgiris in South India.[3] The fauna of Baluchistan, on the whole, has little affinity with the Central Asiatic fauna, and, therefore, with the typical fauna of Afghanistan.

Dr. J. E. T. Aitchison, when attached to the Afghan Delimitation Commission, made a collection of Zoological specimens along the southern, western and north-western boundaries of Afghanistan. The fish collection was reported on by Günther,[4] and the following species[5] were recorded:—

1. *Cirrhina afghana* Günther.	Nushki and Kushk.
2. *Discognathus lamta* (H.B.).	Helmand River and Kushk.
3. *Capoeta steindachneri* Kessler.	Nushki and Kushk.
4. *Schizothorax intermedius* McClell.	Kushk.
5. *Schizothorax raulinsii* Günther.	Hari Rud River near Khusan, Bezd, Jam River.
6. *Gobio gobio* Linn.	Kushk.
7. *Nemachilus kessleri* Günther.	Nushki.

This collection reveals for the first time the nature of the fish-fauna of the Murghab River basin, and it is a matter of great surprise that a member of the common Indian genus *Cirrhina* should have been found as far afield as Kushk. It is equally interesting to notice the occurrence of *Capoeta* at Nushki. The fish-fauna of the Murghab River possesses affinities with that of Western Turkestan, Persia and eastern portion of the Central Asiatic region.. The fauna of the Hari-rud contains an endemic species of *Schizothorax*, which is a typically Central Asiatic genus.

The fauna of Seistan is known from two collections one made by Sir Henry McMahon and other officers of the Seistan Arbitration Commission of 1902-1904, and the other by officers of the

[1] Day, *Proc. Zool. Soc., London*, pp. 223-232 (1880).
[2] Hora, *Rec. Ind. Mus., XXV*, pp. 379-382 (1923).
[3] Day, *Fish. India*, pp. 551, 552 (1877).
[4] Günther, *Trans. Linn. Soc., London* (2) V, pp. 106-109 (1889).
[5] After a perusal of an advance typed copy of this article, Prof. L. S. Berg has discussed the specific limits of the species obtained by the Afghan Delimitation Commission in a short article (*Rec. Ind. Mus.*, XXXV, pp. 193-196, 1933).

Zoological Survey of India in the winter of 1918. The study of these collections has shown that in Seistan there are representatives of 9 species of fish,[1] which are listed below:—

1. *Scaphiodon macmahoni* Regan.	Delta of the Helmand.
2. *Garra adiscus* (Annandale).	Nasratabad and Hamun-i-Helmand.
3. *Garra phryne* (Annandale).	Quetta and Pishin districts of Baluchistan, Hamun and delta of the Helmand.
4. *Schizothorax zarudnyi* (Nikolsky).	Hamun-i-Helmand.
5. *Schizopygopsis stoliczkae* Steind.	Delta of the Helmand. Headwaters of streams and rivers on the north side of the Himalayas and Hindu Kush.
6. *Schizocypris brucei* Regan.	Waziristan, streams in the neighbourhood of Nasratabad.
7. *Nemachilus tenuis* Day.	Kushk, Rud-i-Seistan, Oxus river system.
8. *Adiposia macmahoni* (Chaud.).	Delta of the Helmand, streams near Nasratabad.
9. *Adiposia rhadinaea* (Regan).	Delta of the Helmand.

The fishes listed above may be separated as a whole into two geographical divisions. 'The Cyprinidae, which do not occur in the highlands of Central Asia, represent an element derived from the country lying south and south-east of the Helmand basin; while the Schizothoracinae and the Cobitidae have been brought by the Helmand from the Hindu Kush and are probably descended from the fish-fauna of the ancient and once extensive Oxus system.' We have already noted above that some of the species are common to the Helmand and the Kabul basins.

Major G. E. Bruce made a small collection of fish in the Wana Toi, a tributary of the Gomal river in Southern Waziristan. Regan,[2] who reported on this collection, found six species in it, *viz.*, *Callichrous pabda* (H. B.), *Barilius vagra* (H. B.), *Scaphiodon irregularis* Day, *Crossocheilus barbatulus* Heckel, *Garra wanae* Regan and *Schizocypris brucei* Regan. With the exception of the last species, all the others are allied to Indian forms. *Schizocypris* represents the Central Asiatic element in this fauna, which is mainly a mixture of the Indian and Baluchistan forms.

The fish-fauna of Persia is scanty and has very little affinity with that of Afghanistan. The fishes of South Persia are remarkably similar to those of Sind and Baluchistan. The fishes of

[1] Annandale and Hora, *Rec. Ind. Mus.*, XVIII, pp. 151-191 (1920).
[2] Regan, *Ann. Mag. Nat. Hist.* (8), XIII, pp. 261-263 (1914).

Western Turkestan[1] are mainly those that have descended from the north or those that have populated the country from the east or west. There is also a certain amount of a Central Asiatic element in this fauna. A species of *Salmo* is found in Western Turkestan, as well as in the rivers on the northern slopes of the Hindu Kush in Afghanistan. On the whole the fauna of Western Turkestan is quite distinct from that of Afghanistan.

The fishes of the countries lying along the north-eastern boundary of Afghanistan are better known. My colleague, Dr. B. N. Chopra, made a large collection of fish in the Chitral Valley from which waters drain into the Kabul River near Jalalabad. There seem to be representatives of five species in this collection, and all of these are typically Central Asiatic and have been recorded by Griffith from Afghanistan. The species belong to the genera *Glyptosternum*, *Nemachilus*, *Schizothorax* and *Oreinus*. The fishes of the Pamirs are known to us from the collection made by Alcock as member of the Pamir Boundary Commission, 1895. In a general way, the Pamirs are simply the broad alluvial valleys of the Aksu and the Ab-i-Panja rivers. On the Pamirs only four species of fish were found, *viz.*, *Schizothorax fedschenkoi* Kess., *Schizopygopsis stoliczkae* Steind., *Schizopygopsis sewerzowi* Herz. and *Nemachilus tenuis* Day. Though the number of species is small, it was observed by Alcock[2] that 'Fishes, all of the Carp family, were numerous in every stream and pool, both adults and fry, the commonest being *Schizopygopsis stoliczkae*. It must be either this fish, or a *Schizothorax* which I identify as *S. fedschenkoi*, that travellers in this region have spoken of as "trout". That fishes are so abundant is probably due to the fact that they have few enemies, and that food, in the form of water-snails and larvae of chironomid flies, is plentiful. *Schizopygopsis* would generally take the small fly-spoon, and *Schizothorax* was best caught with a sunk bait of raw meat'. In describing the fishes of the Pamir Expedition 1928, Berg[3] records the same four species which were collected by Alcock. The fauna of this tableland is thus seen to be limited as regards the number of species. On his way to the Pamirs, Alcock collected fishes in the Yasin river and obtained the following species of fish:—*Schizothorax nasus* Heck., *Schizothorax hodgsonii* Günth., *Ptychobarbus conirostris* Steind., *Nemachilus stoliczkae* (Steind.) and *Nemachilus yasinensis* Alcock. All the species are known to be fairly common in Kashmir and the Himalayas. The fish-fauna of Kashmir, with the exception of the few Indian genera that are found in the valley, consists of the *Schizothoracinae* (several genera), *Cobitidae* (*Nemachilus*) and *Sisoridae* (*Glyptosternum*).

[1] Kessler, 'Pisces' in Fedtschenko's *Reise in Turkestan* (1874).

[2] Alcock, *Report of the Natural History of the Pamir Boundary Commission*, pp. 67-68, 91-92 (1896).

[3] Berg., 'Pisces' in *Abandlungen der Pamir Expedition*, 1928, VIII, pp. 23-28 (1932).

From the above sketch of the ichthyology of Afghanistan and of the countries in its immediate neighbourhood, it is clear that Afghanistan forms an important region from a zoo-geographical point of view. The Hindu Kush forms the southernmost limit (leaving out of consideration the *Salmonidae* introduced in India) of the *Salmonidae* and of several other kinds of fish characteristic of Turkestan, and of the countries lying to north, east and west of it. The typical fishes of Sind, Baluchistan and Persia have no representatives in Afghanistan, and the Indian element in its fauna does not extend beyond Jalalabad. The affinities of the Afghanistan fish-fauna have to be looked for in the fauna of the countries lying to the north-east of it. The *Schizothoracinae*, so characteristic of the Tibetan Plateau, seem to have spread into Afghanistan from the north-east, and extended their range to the south-west as far as Seistan, the basins of the Hari Rud and the Marghab Rivers, and other water courses in the west and north-west of Afghanistan. The physical features of Afghanistan are such that they appear to form natural barriers in connection with the geographical distribution of fishes. The extension of the Central Asiatic forms into Afghanistan may have taken place when the Oxus basin was very extensive.

Description of the Collection.

a. A small collection of fish from the Paghman River.

The following description of the Paghman River has been supplied by the Secretary, British Legation, Kabul:—'The Paghman stream is a hill torrent which rises in the Paghman range, and runs past Paghman, about fifteen miles from Kabul. When in flood this stream probably joins the Kabul river, near Kabul City, but in normal times nearly all its water is taken off for irrigation, and what little is left disappears underground. The stream bed is rocky and there is practically no vegetation in it. The current is swift. In late summer and autumn the stream, which is snow fed, dwindles down to a mere trickle'. In August 1932 the Surgeon to the British Legation sent a small collection of fish from the Paghman river to the Bombay Natural History Society. It consisted of 4 specimens, one of *Glyptosternum*, two of *Nemachilus* and one of *Orcinus*. The two specimens of *Nemachilus* appear to belong to *N. griffithii* Günther, though on account of their small size they exhibit important differences from the type-specimens preserved in the British Museum (Nat. Hist.). A complete description of the specimens is given below. *Glyptosternum reticulatum*, though originally described from the Kabul River, is now known to be widely distributed in the headwaters of the Indus and of Amu-Darya and the Syr-Darya in Western Turkestan. The young specimen of *Orcinus* appears to belong to *O. sinuatus* var. *griffithii* McClelland. The systematic position of the last two forms has not been properly understood so far.

Glyptosternum reticulatum McClelland.

1842. *Glyptosternon reticulatus*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 584.
1876. *Exostoma stoliczkae*, Day, *Proc. Zool. Soc. London*, p. 782.
1905. *Parexostoma stoliczkae*, Regan, *Ann. Mag. Nat. Hist.* (7), XV, p. 183,
1932. *Glyptosternum reticulatum*, Hora, *Ann. Mag. Nat. Hist.* (10), X, pp. 176-179.
1932. *Glyptosternum reticulatum*, Hora, *Current Sci.*, I, p. 130.

The single specimen of *Glyptosternum reticulatum* is about 5 inches in length, and is in a fairly good state of preservation. The species was originally described from 'Sir-i-Chushma, at the source of the Kabul river'. Griffith in his notes no doubt refers to this fish when he says that in the small channels by which the springs at Sir-i-Chushmah run off: 'The most remarkable fish however is a dark coloured Loach-like Silurus, which is not uncommon about Julraiz'. *G. reticulatum* was insufficiently characterized by McClelland, and has been the source of considerable confusion in the taxonomy of certain Sisorid fishes. After an examination of a very large collection of this species from the Chitral river, it was pointed out by me that *Parexostoma stoliczkae* (Day) is probably a synonym of *G. reticulatum* McClelland. The discovery of a specimen of this species from a stream near Kabul leaves no doubt whatsoever about the systematic position and specific limits of McClelland's much-discussed species. With this knowledge, it will now be possible to apply the generic names *Glyptosternum*, *Glyptothorax*, *Exostoma*, etc., in terms of the International Rules of Zoological Nomenclature.

G. reticulatum is found in the headwaters of the Indus and in Eastern and Western Turkestan.

Nemachilus griffithii Günther.

(Plate, figs. 1 and 2).

D. 2/7; A. 2/5; P. 10; V. 8; C. 16, besides smaller rays at the sides.

The two specimens of *Nemachilus griffithii* are long and narrow with the head markedly pointed anteriorly and the body tapering gradually towards the posterior end. The opercular region of the head is very prominent. The head and the part of the body in front of the ventrals are somewhat depressed and flattish both on the dorsal as well as on the ventral surfaces. The length of the head is contained 5 to 5.1 times in the total length with the caudal and 4.1 to 4.2 times in the length without the caudal. The height of the head at occiput is contained 1.7 to 1.8 times in the length of the head, while its width is contained 1.3 times in its length. The eyes are small, dorso-lateral in position and are not visible from the ventral surface; the diameter of the eye is contained 5 to 6 times in the length of the head, 2.2 to 2.6 times in the length of the snout and 1.4 to 1.5 times in the interorbital width. The snout is somewhat longer than the postorbital part of the head. The nostrils are situated immediately in front of the eyes; the

posterior nares are well-marked, while the anterior ones are small and tubular and are situated at the bases of broad and triangular processes which cover them completely and hide them from view. The mouth is small, lunate and subterminal. The lips are fleshy and continuous at the angles of the mouth; the lower lip is interrupted in the middle. The upper jaw forms a vertical plate which is convex at its free end; the lower jaw is sharp and shovel-like. When the mouth is closed the upper jaw lies in front of the lower jaw. The barbels are thin and long; the outer rostral and the maxillary barbels are subequal, being almost as long as the snout. The inner rostral barbel is much shorter.

The body is devoid of scales; it is greatly shrivelled up due to preservation so that its height is difficult to judge, but so far as it can be ascertained the greatest depth of the body is contained 9 times in the total length and 7.3 to 7.4 times in the length without the caudal. The caudal peduncle is compressed from side to side, its least height is contained 2 to 2.2 times in its length. The lateral line is almost complete; it is only irregularly interrupted towards the end.

The commencement of the dorsal fin is almost equidistant between the tip of the snout and the base of the caudal fin; it may be slightly nearer to the latter than to the former. The free end of the dorsal fin is subtruncate with the anterior corner more or less rounded; the dorsal fin commences considerably in advance of the ventral; the second divided ray is the longest and it is as long as the greatest width of the head. The ventral fin is long and narrow: it extends considerably beyond the anal-opening, and is separated from the anal fin by a short distance. The caudal fin is slightly shorter than the head and is preceded, both above and below, by a number of small rays. It is obliquely truncate with the upper portion slightly longer than the lower.

Of the two specimens, the larger one appears to be a male, though the characteristic secondary sexual characters of the male are not well defined in it. There is a shallow groove in front of the eye, but the tubercular pads associated with it are absent. The four outer rays of the pectoral fin, to a certain extent the fifth ray also, are broad, bony and curved, but they lack the tubercular pads on the dorsal surface. Secondary sexual characters of a similar nature are found in the males of *N. brauhi*.

The smaller specimen is more conspicuously marked than the larger one. The latter is greyish above and olivaceous below. The dorsal surface, especially in front of the dorsal, is marked with faint cross bands. The caudal and the dorsal fins are minutely speckled, while the other fins are provided with indistinct marks. In the smaller specimen the body is much darker and 7 short, saddle-shaped bands on the dorsal surface are well marked. The dorsal surface of the head is irrorated with small, black dots; while the caudal, dorsal and pectoral fins are conspicuously marked with irregular black bands formed of series of blotches. The ventral fin is provided with one series of spots across it and the anal fin with two similar series. The inner rostral barbels as well as the tips of the other two pair are deep orange-red in colour.

Measurements in millimetres.

Total length including caudal fin	84.2	99.0
Length of caudal	15.0	18.5
Depth of body	9.3	11.0
Length of head	16.5	19.6
Length of snout	7.4	8.6
Interorbital distance	5.0	4.8
Diameter of eye	3.3	3.3
Height of head at occiput	9.0	11.7
Width of head	12.2	15.0
Length of caudal peduncle	15.5	18.0
Least height of caudal peduncle	7.6	8.0
Longest ray of dorsal	12.3	14.6
Longest ray of anal	10.5	12.0
Length of pectoral	13.2	15.5
Length of ventral	11.0	12.8
Distance between pectoral and ventral fins	12.0	10.0
Distance between commencement of dorsal and tip of snout ...	35.0	41.0

Remarks. Griffith in his notes says that 'in the small channels by which the springs (at Sir-i-Chaushmah) run off, a loach is very common'. It is quite probable that *Nemachilus griffithii* is the species which was observed to be very common by Griffith at the source of the Kabul River. The only other record of this genus from Afghanistan is, as I have shown elsewhere,[1] from the Arghandab near Kandahar. The type specimens in the British Museum differ from the two specimens described above and these differences may be tabulated below as follows:—

Paghman river specimens.	*Type specimens.*
Length of head 4 times in total length without caudal.	Length of head 5 times in total length without caudal.
Ventral fins extend considerably beyond anal-opening, and almost reach base of anal fin.	Ventral fins just reach anal opening, and are separated from base of anal fin by considerable distance.
Outer rostral barbel as long as snout.	Outer rostral barbel 2/3 length of snout.
Mouth-opening small.	Mouth-opening relatively wider.

In evaluating the above characters it should be borne in mind that the two specimens from the Paghman River are 3.4 and 4 inches in length respectively; while the two type specimens are 'Five and a half inches long'.

According to Griffith the loach of Sir-i-Chushmah is also said to occur 'in the Helmand at Girdun Dewar, altitude 10,500 feet'. We have already seen that a number of species are common to the Helmand and the Kabul basins, and it is likely that *N. griffithii* is fairly widely distributed in Afghanistan.

[1] Hora, *Journ. As. Soc. Bengal* (n.s.) XXIV, pp. 481-484 (1929).

Oreinus sinuatus var. **griffithii** McClelland.

1842. *Oreinus Griffithii*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 581.
1842. *Oreinus maculatus*, McClelland, *ibid.*, p. 580.

Specimens of the genus *Oreinus* seem to have been collected by Griffith from the head of the Ali Musjid stream (Khyber Pass), Gandamak, Pashat and Girdun Dewar. The Helmand river examples (Girdun Dewar) were referred by McClelland to *O. plagiostomus* Heck., while those collected at Pashat (Kunar river) were described as *O. griffithii*. The other specimens from the Ali Musjid stream and Gandamak were referred by him to his earlier species —*O. maculatus*—from the Simla Hills. In the case of the last species there seems no doubt that he had only young specimens. *O. griffithii* is similar to *O. sinuatus* Heckel, but the species of this genus are so ill defined that it seems advisable to retain the Kabul river form as a separate variety at least for the time being.

The specimen from the Paghman River is 4.6 inches long, and corresponds in all essential respects with a large number of specimens collected by my colleague Dr. B. N. Chopra in the Chitral Valley from the Chitral River (or Kunar River) and its tributary streams. Among the characters of *O. griffithii* McClelland mentioned, 'Dorsal spine large, vertical scales at the anal obsolete, posterior margin of the operculum round, snout smooth', and pointed out that the 'species although perfectly distinct, differs but little in appearance from *Oreinus plagiostomus*'. Unfortunately no specimen of *O. griffithii* was despatched by McClelland to the 'Museum at the India House', though a number of examples of the other species were sent.

b. A note on a species of Trout from the Hindu Kush.

In his notes concerning the fishes of Afghanistan Griffith[1] remarked that 'On crossing the great chain, separating Afghanistan from the plains of Toorkistan, which may be accomplished without exceeding an altitude of 13,000 feet, even by taking the highest route, that of the Erak Pass, a great change in the fish appears to occur, and Salmonidae appear to take precedence of the Cyprinidae'. He found that a species of trout 'abounds in the Bamean river, and up its small tributaries derived from the Koh-i-Baba to an altitude of 11,000 feet'. 'The curious change in the fish', he further observed, 'does not appear to be accompanied by any marked change in the physical configuration of the country, in its plants, animals, or birds'. This trout was described as *Salmo orientalis* by McClelland[2] and stated to 'differ from all known members of the family in the size of the head and the depth of the body. He remarked further that this was the 'first instance of Salmon having been found anywhere in the vicinity of India. There are no *Salmonidae* in Afghanistan, or any of the

[1] Griffith, *Calcutta Journ. Nat. Hist.* II, p. 556 (1842).
[2] McClelland, *ibid.* p. 585 (1842).

countries to the south of the Hindoo Koosh; the latter would therefore appear to be the boundary between the peculiar species of India, and those of Europe and northern Asia'. Next year, 1843, he[1] published a 'Memorandum regarding *Salmo orientalis*, or Bamean Trout', in which he tried to explain the absence of *Salmonidae* from Indian waters (a few species of Trout have since been introduced in the Nilgiris and the Kulu Valley) by assuming that 'However suitable the Himalayan and other mountain streams south of the boundary just noticed might be in point of temperature, and other circumstances adapted to the development of the young Salmon, yet the tropical seas into which these waters fall would be fatal to them, so that the absence of Salmon may be easily accounted for in all countries, the rivers of which have no communication with the seas of the temperate climates. The sea is essential to Salmon, indeed it is their natural abode, as they leave it only for the purpose of spawning. It is evident, therefore, that the Salmon must ascend the Oxus from the Sea of Aral, a distance of 1,200 miles, to the place where they were discovered by Mr. Griffith at an elevation of 11,000 feet, nearly equal to the mean elevation of the highest chain of the Alps, from Mount Blanc to Mount Rosa'. Though McClelland had given a new name[2] to this trout, he was very diffident about it and remarked that 'as specimens have been sent to England[3] with the collections of Mr. Griffith, the question may there be decided'. According to Griffith the Hindu Kush trout 'takes the worm greedily, generally gorging the hook. In sunny days, in winter, it takes the fly freely, although the cold is exceedingly severe'.[4] The species is also found at Bajgah a few marches from Bamean nearer the plains of Turkestan where according to Captain Hay it is said to attain a considerable size, and its flesh is very delicately flavoured.

Though McClelland had sent 3 specimens of the Bamean Trout to England, it seems that they were not available in the British Museum when Günther[5] wrote his *Catalogue of Fishes*, for he says regarding the Trout from the rivers of the Hindu Kush that 'This species appears to be the southernmost in Central Asia, and the nearest to the Indian region. There are no Salmonids in Afghanistan or any of the countries to the south of the Hindoo Kush. McClelland named this fish *Salmo orientalis*, which name cannot be retained, if the fish should prove to be a distinct species, as it was given to another fish by Pallas. The notes added by McClelland allude to characters of the genus only; and the figure (pl. 1) is too rude to assist in the determination of the species'.

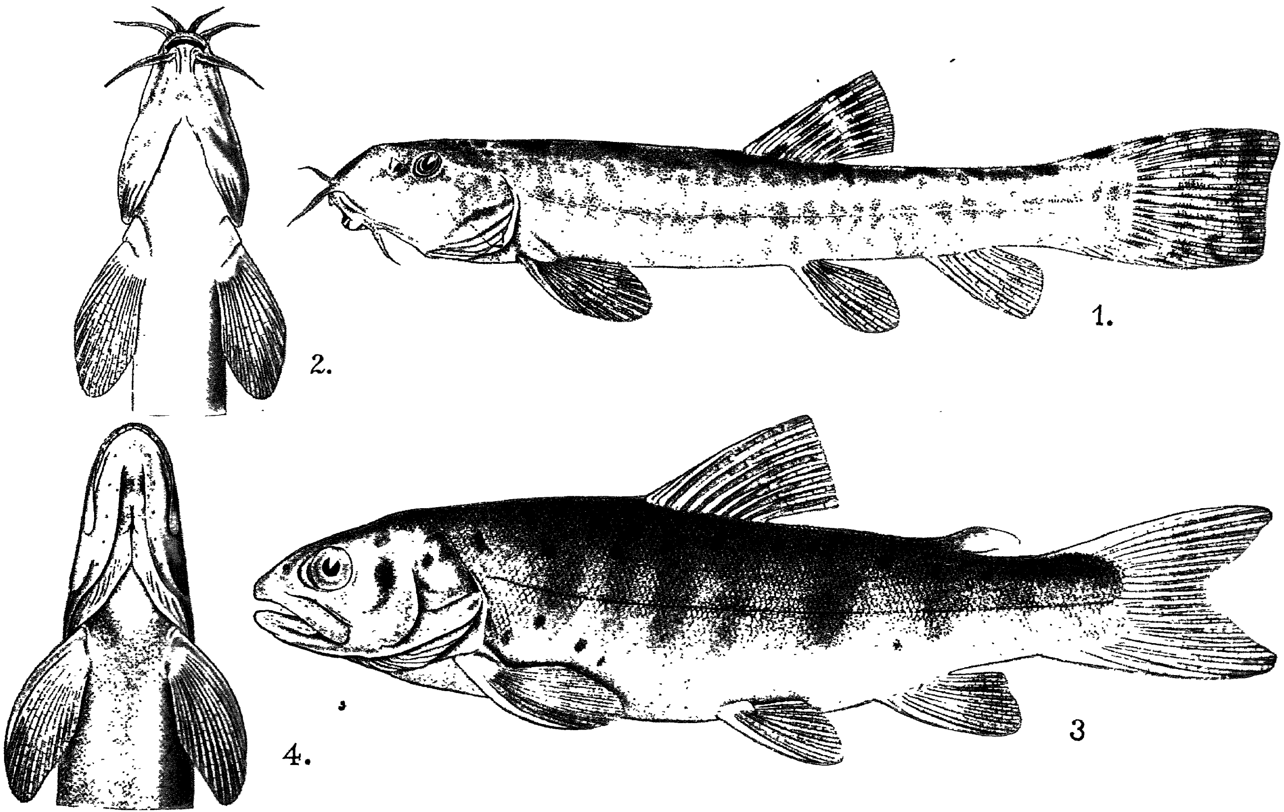
[1] McClelland, *Calcutta Journ. Nat. Hist.* III, pp. 283-287 (1843).

[2] McClelland's choice of the name *Salmo orientalis* was, apart from other considerations, unfortunate as a trout with the same name had already been described by Pallas in 1811.

[3] From the list of specimens sent to England by McClelland (*Cal. Journ. Nat. Hist.*, II, p. 573) it is seen that 3 specimens of *Salmo orientalis* were sent by him to the Museum at the Indian House.

[4] McClelland, *Calcutta Journ. Nat. Hist.* III, p. 287 (1843).

[5] Günther, *Cat. Fish. Brit. Mus.*, VI, p. 115 (1866).



R. Bagchi del.

FISH OF AFGHANISTAN.

Since McClelland's time *Salmo oxianus* has been described by Kessler[1] from Darant river which falls into Kizil-su, one of the upper tributaries of the Oxus. Berg[2] has described *Salmo aralensis* from the same river system. Boulenger[3], however, regarded the southernmost trout as *Salmo trutta* var. *fario* Linn. To an ichthyologist there is no other group of fishes which offers so many difficulties with regard to the distinction of species as the *Salmonidae*, and as there is no material of this group in the collection of the Indian Museum I am not in a position to express an opinion on the specific position of the Bamean Trout, but having recently obtained a specimen from the Hindu Kush I propose to describe it in detail for convenience of reference in future.

The Bamean Trout.

(Plate, figs. 3 and 4).

Mr. (now Sir) R. R. Maconachie sent to the Secretary of the Bombay Natural History Society in February, 1931, a specimen of a trout from N. Afghanistan with the following remarks: 'It appears to be a brown trout and is called a trout by the Afghans, but British officers in India with whom I have discussed the subject are very sceptical as to the occurrence of true trout in Afghanistan. The specimen sent was caught at Bamean 100 miles north of Kabul, and similar fish are said to be abundant in rivers north of the Hindu Kush'. The specimen is, unfortunately, not in a good state of preservation as it has become hard and crooked on account of desiccation. There is no doubt, however, that it represents a true trout and the same species to which reference was made by Griffith. In the collection of the Zoological Survey of India there are two other specimens collected in north Afghanistan. One[4] of these (No. 11406) was collected by Dr. G. M. Giles of the Gilgit Mission at an elevation of 8,000 ft. from the Kokcha river which lies in the north-east of Afghanistan. The other[5] specimen (No. F 1560/1) was obtained by Sir Henry Hayden at an altitude of 10,000 ft. from a small stream running into Ak (Agh) Robat Kotal (Pass) to join Bamean river, N. Afghanistan. The last two specimens are labelled *Salmo oxianus* Kessler and *S. fario oxianus* Kessler respectively. The specimen obtained by Sir Henry Hayden is in a good condition and, consequently, the following description and figures are made from this example, which is about 6.5 inches in total length (Parr-state).

[1] Kessler, 'Pisces' in Fedtschenko's *Reise in Turkestsn*, p. 35 (1874).

[2] Berg, *Ann. Mus. Zool., St. Petersburg*, XIII, pp. 315-323 (1908).

[3] Boulenger, *Field*, cxi, p. 393 (1908). (Not seen, quoted from Berg, *op. cit.*, p. 48).

[4] On the 17th December, 1886, 4 specimens of *Salmo* (Nos. 11403-11406) were registered as having been obtained by Dr. G. M. Giles (Gilgit Mission) in the Kokcha river; but, unfortunately there is only one specimen now, the history of the other three is not given in the register.

[5] This is also one of the three specimens obtained by Sir Henry Hayden, the other two cannot be traced in the collection.

D. 3/8; A. 2/9; P. 13; V. 9; C. 19.

In the Bamean Trout the head and the body are gracefully stream-lined and are compressed from side to side. The length of the head is contained 3.5 times and the greatest depth of the body, which is just in front of the commencement of the dorsal, is contained 3.8 times in the total length without the caudal. The width of the head is contained 1.7 times and its height at occiput 1.6 times in its length. The diameter of the eye is contained 4.6 times in the length of the head, 1.2 times in the length of the snout and 1.3 times in the inter-orbital width. The opercular bones are thin and the hind border of the gill-cover is obtusely rounded; the suboperculum projects beyond the operculum and forms the hindermost projection of the gill-cover. The posterior point of junction of operculum and sub-operculum is slightly nearer to the lower anterior angle of the sub-operculum than to the upper end of the gill-opening. The pre-operculum has a very short lower limb; its hind border is rounded and convex. The operculum is short, its length being contained 1.3 times in its depth. The snout is rather short and obtusely pointed; the maxillary bones are much longer than the snout and extend to below the posterior margin of the orbit. The eyes are fairly large, almost lateral in position, slightly visible from the dorsal surface, but not visible from the ventral surface. The diameter of the eye is contained 4.6 times in the length of the head, 1.2 times in the length of the snout and 1.3 times in the interorbital distance. The nostrils are small and are placed much nearer the eyes than the tip of the snout. The mandible, maxillary, intermaxillary and palatine bones are provided with small, sharp and inwardly-directed teeth. There is a single row of 7 to 8 teeth in the middle line of the anterior portion of the vomer and there is a double row of teeth on the tongue.

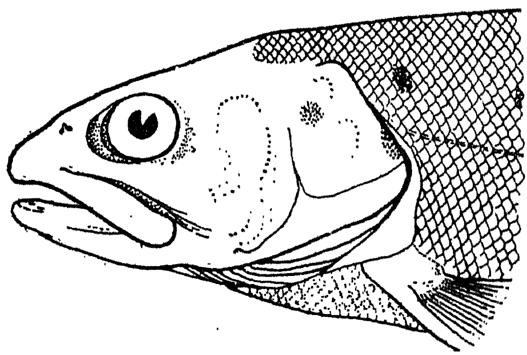


Fig. 1.—Lateral view of head and anterior part of body of the Bamean Trout (*Salmo trutta* var. *fario* Linn.).

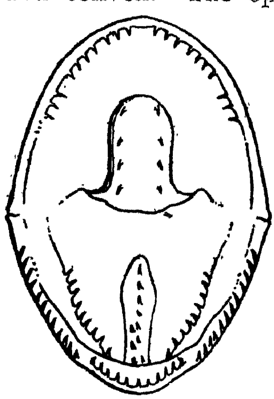


Fig. 2.—Arrangements of tooth-bands of the Bamean Trout (*Salmo trutta* var. *fario* Linn.). Diagrammatic.

The dorsal fin commences considerably in advance of the ventral, and its commencement is much nearer to the tip of the

snout than to the base of the caudal. The adipose dorsal is short and is situated posterior to the base of the anal fin. The longest ray of the anal fin is twice the length of its base. The pectoral fin is pointed and is much shorter than the head; it is separated from the ventral fin by a distance equal to the post-orbital portion of the head. The ventral fin is much shorter than the pectoral and is provided with a fleshy appendage in its axil. The anal-opening is situated at the base of the first ray of the anal fin and is preceded by a narrow groove bordered by scaly flaps. The caudal fin is slightly emarginate. The caudal peduncle is very muscular; its least height is contained 1.7 times in its length.

The lateral line is complete and distinguishable; it runs from behind the gill-opening to the middle of the base of the caudal fin. The scales are small and silvery; there are about 27 rows of scales between the lateral line and the base of the dorsal fin.

There are about 8 broad, dusky cross bars on the body which are distinguishable when the specimen is kept in spirit. There are numerous, irregularly distributed black spots on the head, above the pectoral fin and more particularly on the sides of the body above the lateral line. The fins are without any special markings. Behind the eye there is usually a patch of black pigment, and also just near the hinder end of the gill-cover.

Measurements in millimetres.

Total length without caudal	125.0
Length of head	35.3
Width of head	20.0
Height of head at occiput	21.8
Length of snout	9.7
Interorbital width	10.0
Length of maxillary	17.5
Diameter of eye	7.7
Depth of body	33.0
Length of caudal peduncle	24.0
Least height of caudal peduncle	14.0
Length of pectoral	25.5
Length of ventral	19.3
Length of dorsal	22.5
Length of anal	21.0

Remarks.[1] Kessler[2] in decribing his *Salmo oxianus* referred to *S. orientalis* McClelland (*nec* Pallas), but regretted that it was not possible to define the specific limits of McClelland's species from his descriptions and figures. He indicated that his species was closely related to *S. fario*, several varieties and subspecies of which were known to occur in fresh waters throughout their lives. Berg[3] in describing *Salmo trutta aralensis* referred to the Turkestan Trout and indicated that it should be designated as *Salmo*

[1] Mr. L. Bogdanov has helped me with the Russian text of Kessler's and Berg's descriptions of species, and for this I offer him my sincerest thanks.
[2] Kessler, 'Pisces' in Fedtschenkoi's *Reise in Turkestan*, p. 36 (1874).
[3] Berg, *Ann. Mus. Zool. Acad. Imp. Sci., St. Peters*, xiii, pp. 315-316 (1908).

fario oxianus Kessler (the specific name *orientalis* of McClelland being preoccupied). In his opinion the Turkestan variety could be distinguished from the typical form by its longer head and greater number of gill-rackers. The Aral Salmon was characterized by him as a subspecies of *Salmo trutta*, and distinguished from the typical form by its longer head, longer maxilla and mandible, and by the relatively shorter distance between the pectoral and the ventral fins. He also pointed out the differences between the Caspian Salmon and the Aral Salmon, both of which are considered as varieties of *Salmo trutta*. Further it is known that *S. fario* is subject to a great range of variations. It is for this reason, I believe, that Boulenger[1] assigned an extensive range of distribution to *S. trutta fario* and included in it the Turkestan Trout.

ADDENDUM.

An advance typed copy of the above article was sent to Professor L. S. Berg of the Institute of Ichthyology, Leningrad, for favour of criticism and suggestions. Prof. Berg has very kindly made a few observations in a letter which throw further light on our knowledge regarding the fish of Afghanistan. In consequence, I have thought it advisable to publish the following abstracts from this letter to facilitate reference in future as well as to complete the above account. I am very grateful to Prof. Berg for the great interest and trouble taken by him.

'From the zoogeographical point of view the fish-fauna of Afghanistan is of extraordinary importance, this land being situated at the limits of Mediterranean (Amu-daria and its drainage, Murghab, Hari-rud, drainage of Hamun Lake), High-asiatic (Pamir, probably Kafiristan also) and Indian (the lower Kabul) subregions.'

'In a paper by E. Keserling entitled "Neue Cypriniden aus Persien" (*Zeitschrift für die Gesammten Naturwissenschaften* xvii, pp. 1-24, pls. i-ix, 1861) are described some species from N.-W. Afghanistan, *viz*. from the Hamun basin and the Hari-rud River.

'P. 3. *Barbus microlepis*, pl. i, from a river at Anardareh between Herat and Lash, system of Hamun Lake. Nomen praeoccupied = *Schizothorax zarudnyi* (Nik.).

'P. 11. *Scaphiodon heratensis*, pl. v, from Hari-rud at Herat. — *Varicorhinus heratensis*.

'P. 14. *Scaphiodon asmussi*, pl. vi, from warm springs at Sultan Karaul, 8 miles N.-E. of Herat. = a form of *V. heratensis* with deeper body.

'P. 16. *Discognathus variabilis* Heck. from a rivulet at Anardareh. — *Discognathichthys rossicus* (Nikolsky) or *D. rossicus* infraspecies *nudiventris* (Berg) 1905.

'P. 19. *Bungia nigrescens*, pl. viii, from Hari-rud at Herat. Probably = *Gobio gobio lepidolaemus* with broken pharyngeal teeth (5-5 according to Keserling, instead of 5.2-2.5).

'P. 21. *Squalius latus*, pl. ix, from Hari-rud at Herat = *Leuciscus latus*.

'More details are to be seen in my Fishes of Turkestan, *Faune de la Russie* and *Poissons des eaux douces de la Russie*.

[1] Boulenger, *Field*, cxi, p. 393 (1908).

'Besides the species mentioned by Keyserling there are known from the rivers Hari-rud (= Tejen or Tedshen) and Murghab the following species:—

'*Schizothorax pelzami* Kessler.
Alburnoides bipunctatus eichwaldi (Filippi).
Nemachilus malapterurus (Val.).
Cobitis aurata Filippi.'

'If you include *Salmo orientals*, or *S. oxianus*, in the fauna of Afghanistan, you have to enumerate also all the species occurring in the Upper Amudaria, *viz.*, *Pseudoscaphirhynchus kaufmanni* (Bogdanov), *Ps. hermani* (Kessler), *Salmo trutta aralensis* morpha *oxianus* (*fario*), *Rutilus rutilus aralensis* Berg, *Aspiolucius esocinus* (Kessler), *Varicorhinus heratensis steindachneri* (Kessler), *Barbus capito conocephalus* Kessler, *Barbus brachycephalus* Kessler, *Schizothorax intermedius* McClelland, *Alburnoides bipunctatas eichwaldi* (Filippi), *Capoctobrama kuschakewitschi* (Kessler), *Cyprinus carpio*, *Abramis sapa* (Pallas), *Pelecus cultratus* (Linné), *Nemachilus oxianus* Kessler, *N. amudarjensis* Rass, *N. stoliczkae* (Steind.), *N. malapterurus longicauda* (Kessler), *Silurus glanis* Linné and *Glyptosternum reticulatum* McClell.'

'I do not doubt that *S. orientalis* McClell and *S. oxianus* Kessler refer to the same fish. It is a fresh-water form (morpha *fario*) from the anadromous *Salmo trutta aralensis* Berg. I do not regard it as synonymous with *S. fario* Linné; the last form is a fresh water derivative from the northern *S. trutta trutta*. The synonyms under *Salmo fario* in my book 'Fresh-water fishes of Russia', 1916, pp. 47-48, refer to all the three subspecies of *S. trutta*, *viz.*, *S. trutta trutta*, *S. trutta labrax*, *S. trutta aralensis*. The morphae *fario*, of these subspecies although bearing the same name *fario*, are distinct. In my Fauna de Russie, Poissons, the same names are used everywhere for parallel morphae, for example, high forms of *Cyprinidae* are designated as morpha *elata*, elongate ones as morpha *elongata* (without any author's name).

'It would be of interest to ascertain the number of vertebrae in *Salmo oxianus*. The Mediterranean brook trout described as *S. macrostigma* Dum., has fewer vertebrae (average 57.0) than the northern *S. fario* (average 58.7 from the Baltic drainage).

'To the fauna of Afghanistan must be added also *Nemachilus boutanensis* McClell., *N. griffithii* Günther and *Silurus afghana* Günther.'

EXPLANATION OF PLATE.

Nemachilus griffithii.

Fig. 1.—Lateral view of Paghman specimen × 1½.
Fig. 2.—Ventral surface of head and anterior part of body of same × 1½.

The Bamean Trout.

Fig. 3.—Lateral view of the specimen obtained by Sir Henry Hayden in N. Afghanistan. Same size.
Fig. 4.—Ventral surface of head and anterior part or body of same. Same size.

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RECORDS

of the

INDIAN MUSEUM

Vol. XXXVI, Part III, pp. 279—319

The Fish of Chitral.

By
SUNDER LAL HORA

CALCUTTA:
OCTOBER, 1934

THE FISH OF CHITRAL.

By SUNDER LAL HORA, *D. Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.*

(Plates III and IV.)

In the summer of 1929, a small party of the Zoological Survey of India was sent to Chitral to investigate the zoology and anthropology of the country. At the same time, Dr. G. Morgenstierne of Oslo, after obtaining permission and necessary facilities from the Government of India, went to Chitral to study the languages, folklore, custom and dramatic performances of the Kafirs of Kafiristan. The zoological section of the party, which worked under the leadership of Dr. B. N. Chopra, visited several places in the valley and made extensive collection of fish, besides that of other animals.

According to the Imperial Gazetteer of India,[1] Chitral is a state in the Dir, Swat and Chitral Agency of the North-West Frontier Province and lies between 35° 17′ and 37° 8′N. and 71° 22′ and 74° 6′E.; it has an approximate area of 4,500 square miles. The state is bounded on the north by the Hindu Kush range, on the west by Badakhshan and Kafiristan, on the south by Dir and on the east by the Gilgit Agency, Mastuj and Yasin. Generally, Chitral, like Kafiristan "consists of an irregular series of main valleys, for the most part deep, narrow, and tortuous, into which a varying number of still deeper, narrower, and more difficult valleys, ravines and glens pour their torrent waters. The mountain ranges which separate the main drainage valleys from one another are all of them of considerable altitude, rugged and toilsome."[2] (Pl. iv, figs. 1, 2.) The Chitral River, which is the principal river of the valley, is formed by the union of two large streams, the Lutkuh from the north-west and the Mastuj from the north-east (pl. iv, fig. 2). These streams arise along the southern slopes of the Hindu Kush and join each other about four miles above the town of Chitral. The Chitral River (Plate iii) flows almost due north and south and is joined by a number of streams along its course; these are the Rambhur and the Bomboret joining near Ayun, the Shishi joining near Drosh and the Lahozai joining near Mirkhani. At this place the river takes a south-west course and at Arnawai (or Arandu, as it is known locally) it passes out of the Chitral territory. In its lower reaches it is called the Kunar River and joins the Kabul River near Jallalabad. The banks are for the most part steep and high, but in places the river flows through a broad and fertile valley and its water is extensively used for irrigation. During summer months the river carries a very large amount of silt in suspension giving the water a distinctly reddish tint, on account of the colour of the soil over which it flows.

[1] *Imp. Gazetteer of India*, X, p. 301 (1908).
[2] Robertson, *The Kafirs of the Hindu-Kush*, p. 66 (London : 1896).

The tributaries of the Chitral River, such as Lutkuh and Mastuj flow through deeper valleys and amid more precipitous hills. In consequence, the nature of their beds and the swiftness of their currents correspond more closely with the torrential streams on the southern slopes of the Himalayas. A brief description of the various streams, in which collection of fish was made, is included under the list of localities (*vide infra*, pp. 283-285).

The ichthyology of Chitral proper has never been studied before, though Griffith in his travels through Afghanistan made a collection of fish in the Kunar River near Jallalabad and remarked that "The fish of the Koonur River, the largest tributary of the Kabul River, so far as I know, are all characteristic of Afghanistan, consisting of a Barbus with an elongated body, enormously developed fleshy lips, the lower being three-lobed, another Barbus, and one or two Oreini".[1] The two species of 'Barbus' referred to in Griffith's notes are evidently *Schizothorax labiatus* (McClelland) and *Sch. esocinus* Heckel, and the *Oreinus* is probably *O. sinuatus* var. *griffithii* McClelland, a very variable form as is clear from Dr. Chopra's collection from the Chitral Valley. Besides these three species, Dr. Chopra collected a large series of specimens of *Glyptosternum reticulatum* and of a new species of *Nemachilus*. It is probable that the two latter species are characteristic of swift currents and are not found in the Kunar River at Jallalabad, where several Indian species were also collected by Griffith in the Kabul River.

Robertson [2] observed that the rivers of Kafiristan "teem with fish which no Káfir could be persuaded to eat. The people declare that fish live on dirt, and shudder at the idea of using them for food, as we would shudder at the idea of eating rats". Griffith [3] also noticed that "The fish of Afghanistan, except perhaps those of the valley of Peshawar, cannot be considered as administering to any extent to the food of the inhabitants. It is only about Jallalabad, and more especially along the Koonur valley, that I have seen Afghans employed in fishing. The only nets in use are common casting nets, but this method did not appear to me so successful as that of the hook and line".

Dr. Chopra also observed that "the Káfirs do not eat fish, though the Red Kafirs are now taking to it. They catch fish with their hands by feeling under stones and rocks. They also put a basket under a fall in the course of a stream (pl. iv, fig. 3) and drive fish down into it with their hands and feet working under stones and thus driving the fish out". The common cast net is also employed for catching fish, but these are all very primitive methods and show that the fish are not in much demand in the valley.

As is characteristic of the fish-fauna of any particular valley in Central Asia, the fauna of Chitral is poor in the number of species, only five having been found as enumerated above; while the number of individuals of each species, with the exception of *Schizothorax esocinus*, is very large indeed. *Sch. esocinus* is represented in Dr. Chopra's collection

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[1] McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 565 (1842).
[2] Robertson, *The Káfirs of the Hindu-Kush* p. 68 (1896).
[3] McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 565 (1842).

by a single specimen and is probably a casual visitor to the valley from the lower reaches of the Chitral River. The paucity of species of fish in the valleys of Central Asia is probably due to several causes, the most important of these, however, seems to be that the waters of the valleys have been colonised[1] gradually by the migration of fishes from neighbouring territories. I have already pointed out that "there is no indication in this fauna which shows that it is indigenous and that it has not been derived from the fauna of the low-lying lands of the neighbouring countries". The valleys themselves contain, as is indicated below in the short descriptions of the stations in the Chitral Valley, a fair diversity of habitats to permit a certain amount of 'ecological segregation' to take place so as to influence the production of new species; but the factors that inhibit the multiplicity of species are very powerful indeed. In the first place, access to the valleys of Central Asia to the south of the Hindu Kush is through the tempestuous torrents that flow all along the slopes of the Himalayas, and it will be admitted that the conditions of life are very exacting in these swift and turbulent waters. In consequence, *Nemachilus*, *Glyptosternum* and the Schizothoracinae are the only fish that have been able to invade the higher altitudes and establish themselves in the valleys of Central Asia. It was pointed out by Griffith (*op. cit.*) that some species of Indian fish extend in the Kabul River up to Jallalabad, to the north of which the fauna, so far as the fish are concerned, is typically Central Asiatic. It seems probable, therefore, that the small torrential streams along the southern slopes of the Himalayas form effective barriers for the penetration of sluggish-water species from India and other countries. In the Chitral Valley, there are places where *Barbus*, *Cirrhina*, *Labeo*, etc., if introduced, would probably flourish, but in the normal course these genera have no chance to reach the valley. The species, that were able to cross the barrier, found rich feeding grounds and vast tracts of unoccupied territory. In accordance with biological laws, they multiplied and occupied every suitable niche in the environment and even though they still exhibit marked habitat preference, they developed a certain amount of tolerance for variation in the intensity of environmental factors. This can be clearly seen from the lists of species given below under each station.

The best adapted torrential fish in Chitral is *Glyptosternum reticulatum*; it feeds on insect larvae, such as the Ephemeropterous nymphs of *Iron* and Blepharocerid larvae, which live on or under rocks in very swift currents. *Oreinus*, which is confined usually to the rapids, is a bottom feeder and takes up food indiscriminately, though it seems to feed mainly on the algal matter encrusting rocks and stones in swift currents. *Schizothorax esocinus* is carnivorous, feeding on young fish and decaying flesh; while *Sch. labiatus* feeds on algae, caddis-worms and other insect larvae. Both species of *Schizothorax* live in deeper waters of large rivers and can withstand fairly swift currents. *Nemachilus choprai* lives among rocks and pebbles at the bottom and feeds on algae and insect larvae. From an ecological study of the fish fauna of three Central

[1] Hora, *Phil. Trans. Roy. Soc. London* (B), CCXVIII, p. 268 (1930).

Asiatic rivers, Nikolski[1] has shown that "there are well-marked communities of species associated with different rates of flow of rivers". It has been shown by me[2] that the rate of flow of water is the principal ecological factor that determines the types of association of animals in mountain streams. According to the rapidity of the current, the five Chitral species can thus be arranged in a series: *Glyptosternum reticulatum*, *Orienus sinuatus* var. *griffithii*, *Nemachilus choprai*, *Schizothorax labiatus* and *Schizothorax esocinus*. From certain stations two or more species were collected, but it should be remembered that habitats vary sometimes within a very short distance of one another in the same environment. The five species from Chitral, though superficially they seem to live together, do not appear to compete with one another either for food or for space. The slow waters in Chitral, especially those containing a rich growth of vegetation, seem to be the haunts of young specimens and are, no doubt, the nurseries of the Chitral species.

As has been remarked by Griffith (*op. cit.*), the fish of the Kunar River are all characteristic of Afghanistan. *Sch. labiatus* is widely distributed in Afghanistan both in the Kabul and the Helmand river systems; *Sch. esocinus* is found in the Kashmir Valley and in the Kabul and the Helmand river systems of Afghanistan; *Oreinus sinuatus* var. *griffithii* is also found in the Kabul and the Helmand river systems of Afghanistan and *Glyptosternum reticulatum* has a much wider range of distribution, being found in the head-waters of the Indus, the Kabul, the Syr-Darya and the Amu-Darya rivers. The only endemic species in Chitral is *Nemachilus choprai*, which, in general facies, is very much like its congeners of Central Asia. On account of its close resemblance to *N. kashmirensis* Hora,[3] a full description, with figures, of the latter species is included here to facilitate reference.

Dr. Chopra observed that the fish were most abundant at the junctions of the side streams with the main river. During my recent visit to the Tista Valley in May-June 1934, I noticed that the fish were to be found in large numbers at the junction of the Kalijhora stream with the Teesta river. During my brief stay at Kalijhora, it rained heavily and the water of the river was very muddy. The water of the Kalijhora stream was black. I was informed that the black colour was due to certain friable rocks that lie in the bed of the stream. The black stream did not mingle with the muddy water for about a hundred yards. According to the popular belief the fish like the taste of this water and in consequence gather in large numbers at the junction of the two streams. It is difficult to say, whether there is any truth in this belief or not but there seems no doubt that the small streams flowing through deep, forest-covered valleys bring down large quantities of vegetable débris and detritus with them, especially after heavy rainfall. This leads to a great increase in the available food supply and at the same time large quantities of nutrient salts, derived from the soil, are brought down with the current. Another possible factor is that the waters of the small streams, on account of the tempestuous nature of their currents, are

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[1] Nikolski, *Journ. Animal Ecology* II, pp. 266-281 (1933).
[2] Hora, *Phil. Trans. Roy. Soc. London* (B) CCXVIII, pp. 171-282 (1930).
[3] Hora, *Rec. Ind. Mus.* XXIV, p. 76 (1923).

much more highly oxygenated than those of the main stream. These are some of the possible factors that may account for the abundance of fish at the junctions of small streams with the principal river of a valley.

Reference may here be made to another observation which Dr. Chopra made in the Chitral Valley. On the 24th and 25th of July 1929, Dr. Chopra was camping between Daimali and Karakal in the Bumboret Valley. The Bumboret is a large river formed of a number of snow-fed streams; it has a rocky bed and the water is usually clear. During Dr. Chopra's stay, there was a heavy rainfall in the valley and in consequence the river was flooded. The intensity of the flood was so great that bridges were washed away down the valley and considerable damage was done. The water rose very high in the river and became turbid and muddy. These abnormal conditions must have incommoded the fish, as with the subsidence of water they were found washed along the banks in a dead or dying condition. The majority of these consisted of *Glyptosternum reticulatum* and the only other fish found on the banks was *Oreinus sinuatus* var. *griffithii*. Both the species are specially adapted to adhere to rocks in swift currents and have undergone structural modifications for this purpose; they are not capable of sustained swimming, though they can dart from rock to rock with great rapidity. It seems reasonable to presume that fishes with such habits, once dislodged from their moorings, either by the swiftness of the current, by the disturbance caused by the suspended pebbles and stones in the current or by the choking effect of muddy water in respiration, are probably carried helplessly in deep water by the flood till they are washed on the banks. A number of fishes picked up by Dr. Chopra were merely stupified and were revived by keeping in water. There are previous records of similar happenings in Central Asia and other mountainous countries. Lt.-Col. F. M. Bailey once sent me specimens of *Nemachilus* picked up by him after heavy floods from the bank of a stream in Eastern Tibet.

The following is a list of stations whence Dr. Chopra collected fish in the Chitral Valley. Short descriptions of the stations from Dr. Chopra's field notes and lists of species of fish collected at each station are given.

Sta. 1. 20th-28th June, 31st July and 1st-3rd August, 1929. Chitral or Kunar River near Chitral town.

" A large and broad river of muddy water flowing over a bed of sand and mud with some stones and boulders. The current is moderately swift and the banks are in most places steep and rocky. There is no vegetation in the water."

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax esocinus* Heckel.
iii. *Schizothorax labiatus* (McClelland).
iv. *Oreinus sinuatus* var. *griffithii* McClelland.
v. *Nemachilus choprai*, sp. nov.

Sta. 2. 1st-3rd July and 19th July, 1929. Pallarga stream about 2 miles below Kunisht (Red Kaffir village) in the Rambhur Valley.

" A small stream of clear, rapidly flowing water over stones and rocks in a somewhat north to south direction and joining the Rambhur River

almost midway between Kunisht and Rambhur. Practically no plant life in water, though some trees and shrubs on the banks, which are quite steep in places. The water is considerably warmer than that in the Rambhur River or other streams in the locality." At 12 noon on the 19th of July 1929, the temperature of water in the Pallarga stream was 71·0 F. while that of Rambhur River was only 57°·0 F.

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 7. 24th and 25th July, 1929. Bumboret River between Daimali and Karakal in the Bumboret valley.

"A large river formed of a number of snow-fed streams, running for the most part from south-west to north-east and joining the Rambhur River a few miles above Ayun before falling in the Chitral River. It has a very swift current of clear water flowing over stones and boulders and irrigates by means of side channels an extensive area of land." Heavy floods killed the fish and washed them up the banks.

i. *Glyptosternum reticulatum* McClelland.
ii. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 8. 4th August, 1929. Lutkuh River at Sheghor.

"A very large stream of moderately swift current with water almost dark with suspended mud and clay, flowing over a more or less sandy bed, with comparatively few stones and boulders. No vegetation in the stream."

i. *Schizothorax labiatus* (McClelland).

Sta. 9. 5th and 6th August, 1929. Lutkuh River near Hot-Springs.

"A large stream of rapid current with clear water flowing over a bed of stones and sand. No vegetation."

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus sinuatus* var. *griffithii* McClelland.
iv. *Nemachilus choprai*, sp. nov.

Sta. 12. 20th-27th August, 1929. Mastuj River between Koghazi and Mastuj.

"A large river of muddy water and swift current flowing for the most part over stones and boulders, with occasional patches of sand and mud, between steep banks. No vegetation of any kind in the water."

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus sinuatus* var. *griffithii* McClelland.
iv. *Nemachilus choprai*, sp. nov.

Sta. 13. 29th August, 1929. A small stream near Surguz in the Mastuj Valley.

"A stream of clear water, originating from some springs and fed by other springs along its course, with a moderately swift current flowing

over a bed of sand and stones, and with plenty of vegetation consisting of grasses and algae."

i. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 14. 30th August, 1929. A small stream above Charun in the Mastuj Valley.

" The stream is fed by a number of springs along its course, has clear water with plenty of vegetation and a bottom of mud and sand with a few stones."

i. *Nemachilus choprai*, sp. nov.

Sta. 15. 6th and 10th September, 1929. Small spring-fed streamlets between Tar and Drosh.

" Small streams of clear water, and slow current used in some places for irrigation, with plenty of vegetation and a somewhat muddy bottom."

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus simatus* var. *griffithii* McClelland.

Sta. 16. 15th and 16th September, 1929. Ramram gol near its junction with the Chitral River below Arandu.

" A large hill stream of clear water, with swift current flowing over stones and boulders and without any vegetation. "

i. *Glyptosternum reticulatum* McClelland.
ii. *Schizothorax labiatus* (McClelland).
iii. *Oreinus sinuatus* var. *griffithii* McClelland.

Before giving the systematic account of the collection, I wish to express here my sincerest thanks to Dr. B. N. Chopra for the valuable information he has supplied to me during the preparation of this report and for his helpful suggestions and to Dr. B. Prashad for going through the manuscript. Mr. R. Bagchi has made all the drawings, except those of *Nemachilus kashmirensis* Hora, under my supervision with great care and skill and for this I am much obliged to him.

Glyptosternum McClelland.

1842. *Glyptosternon*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 584.
1860. *Glyptosternon*, Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 152.
1876. *Exostoma*, Day (in part), *Fish. India*, p. 501.
1889. *Exostoma*, Day (in part), *Faun. Brit. Ind. Fish.*, I, p. 108.
1889. *Glyptosternum*, Vinciguerra, *Ann. Mus. civ.-stoz. Nat. Genova*, XXIX, p. 245.
1905. *Parexostoma*, Regan, *Ann. Mag. Nat. Hist.* (7), XV, p. 182.
1911. *Parexostoma*, Regan, *Ann. Mag. Nat. Hist.* (8), VIII, p. 564.
1922. *Glyptosternum*, Hora (in part), *Rec. Ind. Mus.*, XXIV, p. 33 (foot-note).
1923. *Glyptosternum*, Hora (in part), *Rec. Ind. Mus.*, XXV, p. 30.
1923. *Glyptosternum*, Annandale (in part) *Ann. Mag. Nat. Hist.* (9), XII, pp. 573-577.
1925. *Parexostoma*, Norman, *Ann. Mag. Nat. Hist.* (9), XV, p. 572.
1931. *Glyptosternum*, Myers, *Lingnan Sci. Journ.*, X, p. 260.
1932. *Glyptosternum*, Hora, *Ann. Mag. Nat. Hist.* (10), X, pp. 176-179.
1933. *Glyptosternum*, Smith, *Journ. Siam Soc., Nat. Hist. Suppl.*, IX, pp. 70-74.
1933. *Glyptosternum*, Berg, *Poiss. Eaux Douces, U. R. S. S.*, 3rd ed. pt. ii, p. 596.

In 1922 and more particularly in 1923, I assigned to the genus *Glyptosternum* a group of Sisorid fishes in which the structure of the paired fins agrees with McClelland's description of the fins of *G. reticulatum*. This structure is so remarkable that Blyth seems to have been greatly influenced by it in restricting the name *Glyptosternum* to *G. reticulatum*, which thus constitutes the type of the genus. Though at the time, I was fully aware of the heterogenous nature of the assemblage I referred to *Glyptosternum*, it was not possible then to divide it into genera as the name *Glyptosternum* could not be applied to any of the forms with certainty. Regan [1] and Myers (*op. cit.*) have also indicated that until *G. reticulatum* is rediscovered and redescribed it is not possible to arrive at a satisfactory solution concerning the application of this generic name. Recently, however, I gave reasons to believe that "*Parexostoma stoliczkae*," a widely distributed species in the western parts of Central Asia, is identical with *Glyptosternum reticulatum*, and pointed out that of the several genera, into which Glyptosternoid fishes have been divided, *Parexostoma* Regan becomes synonymous with *Glyptosternum* McClelland. This supposition has received further support from the fact that McClelland's species have been rediscovered [2] from the Kabul River near Kabul in Afghanistan. The Surgeon to the British Legation at Kabul made a small collection of fish in the Paghman River, a tributary of the Kabul River, and this included a specimen of *Glyptosternum reticulatum* (or the hitherto well known species *Parexostoma stoliczkae*). This discovery leaves no doubt about the identity of McClelland's *G. reticulatum* described from Sir-i-Chashma, the source of the Kabul River. From within the limits of Afghanistan the species has also been obtained in the Bannu Anderab River [3] of the Oxus System, about 79 miles north of Kabul. Both Smith and Berg in their recent works have upheld my views regarding the generic identity and limits of *Glyptosternum* McClelland. In view of this evidence it is now possible to split up the composite assemblage and to define the generic limits of each group. The genus *Glyptosternum* may be characterized as follows :—

The genus *Glyptosternum* comprises large-sized and greatly flattened Sisorid fishes in which the head and the anterior part of the body are depressed and the tail is compressed from side to side. The skin is soft except on the ventral surface in front of the anal-opening where it is thickly or sparcely covered with soft papillae. The eyes are minute, almost indistinguishable; they are subcutaneous and are situated on the dorsal surface of the head. The mouth is transverse and is situated considerably behind the tip of the snout. The teeth are pointed, those of the upper jaw form a band which is produced backwards at the sides. The teeth on the lower jaws form two bands which are pointed towards the sides. The fold of the lower lip is broadly interrupted. There are 8 barbels, 2 nasal, 2 maxillary and 4 mandibular ; the mandibular barbels are provided with very broad bases and on the ventral surface in their

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[1] Regan, *Ann. Mag. Nat. Hist.* (9), XI, p. 609 (1923). Berg (*Bull. Acad. Sci. U. R. S. S.*, p. 1267, 1931) used the name *Glyptosternum* for species of the genus *Glyptothorax* Blyth.

[2] Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 697 (1933).

[3] Hora, *ibid.*, XXXVII (*in press*).

outer halves bear striated pads of adhesive skin. The gill-openings are wide, extending to the ventral surface for a short distance. The gill-membrane is broad and free throughout its length. The fins are "without spines, the first ray of the pectoral and ventral fins soft and pinnate, giving off soft, pointed cartilaginous rays along the anterior margin, which are enveloped in the membrane of the fin". The dorsal is situated above or slightly behind the pectorals, but entirely in advance of the ventrals. The adipose fin is long and low. The paired fins are broad, rounded and horizontally placed; they are vertical in their inner and horizontal in their outer halves. The skin on the ventral surface of the first ray of the paired fin is corrugated in pinnate folds for the purposes of adhesion. The caudal fin is truncate, obliquely truncate or somewhat rounded. The air-bladder is greatly reduced and enclosed in two bony capsules.

Type-species. Glyptosternum reticulatum McClelland.

In view of the uncertainty prevailing about *G. reticulatum* I[1] suggested in 1923 that *G. labiatum* McClelland should be considered as the type of *Glyptosternum* instead of *G. reticulatum*. Myers[2] has pointed out that this suggestion is in violation of the International Rules of Zoological Nomenclature, but in view of the rediscovery of *G. reticulatum* no new genotype need be considered.

Geographical Distribution.—So far only two species are known in this genus. *Glyptosternum maculatum* (Regan) is known from Eastern Tibet (Lhasa and Gyang-tse) and Sikkim; whereas the other species *G. reticulatum* McClelland is widely distributed in the head waters of the Indus (Basgo, Sneema, Leh, Ladak and the Kashmir Valley), of the Kabul River (Sri-i-Chushmah, Julraiz[3], Paghman and the Chitral Valley), of the Syr-Darya and the Amu-Darya in Eastern Turkestan (Oxus System).

Glyptosternum reticulatum McClelland.

1842. *Glyptosternon reticulatus*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 584.
1860. *Glyptosternon reticulatus*, Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 153.
1876. *Exostoma Stoliczkae*, Day, *Proc. Zool. Soc. London*, p. 782.
1877. *Exostoma Stoliczkae*, Day, *Fish India*, p. 502, pl. cxvii, fig. 3.
1878. *Exostoma Stoliczkae*, Day, *Sci. Res. 2nd Yarkand Miss.* Ichthyology, p. 1, pl. i, fig. 1.
1889. *Exostoma Stoliczkae*, Day, *Faun. Brit. Ind., Fish.*, I, p. 110, fig. 45.
1889. *Exostoma Oschanini*, Herzenstein, *Mel. biol.*, XIII, p. 69.
1890. *Exostoma Oschanini*, Herzenstein, *Bull. Ac. St. Petersburg*, XXXIII, p. 120.

[1] Hora, *Rec. Ind. Mus.*, XXV, p. 35 (1923).
[2] Myers, *Lingnan Sci. Journ.*, X, p. 260 (1931).
[3] According to Day (*Ichthyology Sci. Res. 2nd Yarkand Miss.*, p. 19, 1878, foot-note), Griffith's remark (*Calcutta Journ. Nat. Hist.*, II, p. 564, 1842) regarding the most remarkable "dark coloured Loach-like *Silurus*, which is not uncommon about Julraiz" probably refers to a species of *Amblyceps*. In my revision of the genus *Amblyceps*, I have indicated (*Rec. Ind. Mus.* XXXV, p. 610, 1933) that *Amblyceps* has never been recorded from any place west of the Kangra valley. I am of opinion that in his remark about "Loach-like *Silurus*" Griffith made a reference to *Glyptosternum reticulatum* which is found in abundance at Sir-i-Chashma.

1905. *Exostoma Stoliczkae*, Berg, *Ryby Turkestana*, p. 211, fig. 31.
1905. *Parexostoma Stoliczkae*, Regan, *Ann. Mag. Nat. Hist.* (7), XV, p. 183.
1907. *Exostoma gracile*, Grazianov, *Trudy Otdela Ichtyologii*, IV, p. 58.
1907. *Exostoma labrax*, Grazianov, *ibid*, p. 59.
1908. *Exostoma stoliczkae*, Berg, *Ezhegodnik Zoologicheskago Muzeya Akademii Nauk*, XIII, p. 450 (1908).
1916. *Parexostoma stoliczkae*, Berg, *Poiss. Eaux Douces Russie*, p. 371, figs. 289, 290.
1923. *Glyptosternum stoliczkae*, Hora, *Rec. Ind. Mus.*, XXV, p. 37.
1925. *Parexostoma stoliczkae*, Norman, *Ann. Mag. Nat. Hist.* (9), XV, p. 572.
1932. *Glyptosternum reticulatum*, Hora, *Ann. Mag. Nat. Hist.* (10), X, p. 179, fig.
1932. *Glyptosternum reticulatum*, Hora, *Cur. Sci.*, I, p. 130.
1933. *Glyptosternum reticulatum*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 697.
1933. *Glyptosternum reticulatum*, Berg, *Pioss. Eaux Douces U. R. S. S.*, 3 ed. pt. ii, p. 597, figs. 549-551.
1934. *Glyptosternum reticulatum*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVII (*in press.*)

From the above synonymy it is clear that *Glyptosternum reticulatum*, instead of being an obscure species as hitherto believed to be, is a well-known representative of the Sisorid group of fishes. Several authors have described it and published its illustrations under the title "*Exostoma stoliczkae*". I, therefore, do not propose to redescribe the species here, but in view of the abundant material before me from the Chitral Valley the following notes should prove useful.

Day (1876) has already indicated the remarkable variation in the comparative length of the head to that of the total length in this species. I have noticed that such a range of variation exists in the relative proportions of all the principal organs. For instance, the length of the caudal fin is contained 6·4—9·8 times in the total length including the caudal. In smaller individuals this fin is relatively longer. The head is also proportionately longer in young individuals; the length of the head is contained 4·9—6·2 times in the total length with the caudal and 4·2—5·6 times without it. The depth of the body is also variable but it is not in any way correlated with the size of the specimen; it is contained 7·3—10·5 times in the total length with the caudal. The caudal peduncle becomes proportionately longer with the growth of the fish; its least height is contained 2·6—3·4 times in its length. The increase in the length of the fins does not keep pace with the growth of the fish. In young specimens the pectorals are separated from the ventrals by a short distance, and the latter are separated from the anal by a still shorter distance. While in fully grown examples these fins are considerably removed from one another. The longest ray of the dorsal is greater than the depth of the body in specimens up to 110 mm. in length while in larger specimens it is considerably shorter than the same dimension. For further details reference may be made to the table of measurements on page 291. It seems probable that the variability of the species has led to its being described under so many different names in various parts of its extensive range of distribution.

Distribution.—It has been pointed out above (p. 287) that *Glyptosternum reticulatum* is widely distributed in the upper reaches of the Indus, the Kabul, the Amu-Darya and the Syr-Darya Rivers. Thus the species is found in Eastern Turkestan and in the mountain regions that border

it on the south and west. In the Chitral Valley, Dr. Chopra obtained 215 [1] specimens from the following localities :—

(i) 37 specimens from the Chitral River near the Chitral town (Sta. 1).
(ii) 18 specimens from the Pallarga Stream 2 miles below Kunisht in the Rambhur Valley (Sta. 2).
(iii) 154 specimens from the Bumboret River between Daimali and Karakal (Sta. 7).
(iv) 2 specimens from the Lutkuh River near Hot-springs (Sta. 9).
(v) 1 specimen from the Mastuj River between Koghazi and Mastuj (Sta. 12).
(vi) 1 specimen from a small spring-fed stream between Tar and Drosh (Sta. 15).
(vii) 2 specimens from the Ramram gol stream near its junction with the Chitral River below Arandu (Sta. 16).

It is clear from the above that *G. reticulatum* is found all over the Chitral Valley and that it is abundant in large rivers and streams. Dr. Chopra has observed that the species is commonly found near the junction of the side streams with the principal river of the valley. Owing to the heavy floods in the valley, a large number of fish were washed on the banks of the Bumboret River and were picked up next day in an almost dead condition.

Berg remarks that *G. reticulatum* (= *Parexostoma stoliczkae*) 'lives under stones'. Dr. Chopra has also observed that in the Chitral Valley the fish lives in fair numbers under stones and rocks. The species lives in large and clear streams with rapid-flowing current and with the bed strewn with rocks and boulders. Except for the algae and slime that cover the rocks in such situations; Dr. Chopra did not observe any vegetation in most of these streams. The nature of the food of these fishes (*vide infra*, p. 290) shows that they brouse over the exposed surface of rocks where they must live under the direct influence of the swift current. So it seems probable that a bed of smooth rocks is essential for these fishes, that their feeding grounds are the exposed surfaces of rocks and that they seek shelter under rocks when frightened or when not feeding. These habits correspond very closely to those of the fishes of the genus *Garra* and other hill-stream fishes.

Sexual Dimorphism and the Proportion of Sexes in the population.— In *Glyptosternum reticulatum* the males do not possess any well-marked secondary sexual characters ; but by dissecting a number of specimens, I have been able to find some difference in the region of the anus by which the sexes can be distinguished readily by a superficial examination of the specimens. Behind the anal opening, there is a deep groove. In the male a sharp, conical, well-developed papilla projects behind the anus in this groove ; whereas in the females, there is no anal papilla but the anal opening is bordered laterally by two prominent lips which cover the groove behind the anus. Judging by these characters, I have been able

[1] In my note on *G. reticulatum* in the *Annals* I mentioned only 176 specimens. Unfortunately, I overlooked to count the specimens in one bottle. Four specimens have been presented to the British Museum (Nat. Hist.), two were sent to Dr. G. S. Myers and a dozen specimens to the Zoological Museum at Moscow.

to divide the 209 specimens into 122 males and 87 females. So far as can be judged by these figures, it seems that males predominate in the population; they form 58·4 per cent as against 41·6 per cent females. Of the 148 specimens from the Bumboret River (6 specimens from this locality have been presented to outside institutions) there are 78 males and 70 females giving a percentage of 52·7 males and 47·3 females. As has been indicated above, these specimens were picked up from the banks of the river after a heavy flood. In these circumstances the males and females must have been equally affected and judging from the above figures there is only a negligible higher percentage of males over the females. The figures indicate that the males and females occur in almost equal proportions. The females are probably less active and of more secretive habits than the males and this would account for the preponderance of males over females from other localities. The samples are, however, not sufficiently large to permit of any generalisation.

Bionomics.—The alimentary canal is not very much convoluted; its length is 0·94 of the total length of the fish. On an examination of the stomach-contents of about a dozen and a half specimens, it was found that the fish feeds on the flattened larvae of Ephemeroptera, such as *Iron* and other Heptageniid larvae, and the *Ephemerellid* nymphs, on the larvae and pupae of Trichoptera and the larvae and pupae of Blepharoceridae. Among the stomach-contents were a few other larvae of the *Baetis*-type (Ephemeroptera) as well as Chironomid and other highly specialised Dipterous larvae. The major part of the food consists of the Heptageniid nymphs of the *Iron*-type. All these insect larvae are specially adapted to live on or under the exposed surfaces of rocks in very swift currents,[1] in fact the Blepharocerid larvae cannot live and have not yet been found in slow currents. It is reasonable, therefore, to conclude that *Glyptosternum reticulatum* frequents exposed, smooth surfaces of rocks in swift currents for the purpose of feeding and that it also searches for the Heptageniid nymphs under stones. The relatively large size which this species attains (Day's largest example was 175 mm. in length, Berg had examples 215 mm. in length and in the present material the largest example is about 230 mm. in total length) shows that it lives in somewhat deeper waters, for large size is a distinct disadvantage in shallow waters. The fish is perfectly adapted for the type of habitat depicted above. Its flattish ventral surface can be closely applied to the hard substratum and by means of the broad, corrugated, outer ray of the paired fins it adheres to rocks. The structure of its paired fins further shows that the fish vigorously pumps out any water that flows on its under surface thus creating a negative pressure for the purposes of adhesion. The broad and reflected lips and the broad maxillary barbels with corrugations on their ventral surface help in adhesion. There is also no doubt that the papillae on the ventral surface are used for the same purpose. The large and unspecialised gill-openings show that the fish breathes continuously; but its large gill-membrane would indicate

[1] Hora, "Ecology, Bionomics and Evolution of the Torrential Fauna," *Phil. Trans. Roy. Soc. London* (B), CCXVIII, pp. 171-282 (1930).

Measurements in millimetres.

	Sta. 2. ♂					Sta. 16. ♂		Sta. 7. ♀		Sta. 7. ♂	
Total length including length of caudal	81·8	84·5	89·0	134·2	147·5	101·8	105·5	160·0	164·5	207·0	225·5
Length of caudal	10·7	10·9	11·8	21·0	20·0	14·0	14·0	19·5	20·3	24·0	23·0
Length of head	16·6	16·5	17·0	26·4	29·0	20·0	21·0	28·8	30·0	38·2	36·0
Width of head in front of pectorals	14·7	15·2	16·0	25·0	28·0	19·2	19·0	27·6	29·2	34·8	36·4
Height of head at occiput	8·8	8·1	8·8	12·7	13·0	10·4	10·1	15·0	15·0	16·8	20·0
Depth of body	9·0	8·9	10·0	17·6	17·6	11·8	12·8	15·2	22·4	26·0	23·2
Length of snout	8·8	8·4	8·8	13·2	16·0	10·8	10·0	14·5	14·6	20·0	18·5
Interorbital width	5·0	4·6	6·0	8·0	9·0	5·8	5·2	9·0	8·7	10·5	11·0
Length of caudal peduncle	16·0	18·2	19·0	28·0	30·0	21·0	20·5	33·0	36·5	48·6	51·0
Least height of caudal peduncle	6·0	6·7	7·1	9·1	10·3	7·0	6·2	10·0	10·5	15·0	16·0
Longest ray of dorsal	13·2	12·0	13·5	16·8	17·2	13·5	13·2	15·0	16·0	22·2	23·0
Longest ray of anal	11·2	10·8	11·6	16·5	18·0	11·7	12·2	16·0	16·0	19·4	22·0
Length of pectoral	19·0	19·3	21·0	30·0	33·3	21·6	22·7	35·0	35·3	39·2	43·0
Length of ventral	15·2	15·0	17·0	23·6	24·5	17·7	17·2	27·0	25·6	29·2	33·3

that the respiration is initiated and carried on by its flapping movements. On rocks the fish seems to crawl with the help of its paired fins by using them alternately and it is likely that the lips and the associated structures also help during progression. Its powerful and muscular tail is no doubt used for darting movements from rock to rock. *G. reticulatum* is a bottom-dwelling fish, and is not capable of sustained swimming in swift currents. It is probable that the broad, lunate band of teeth on the upper jaw is used for rasping off from the rocks encrusting organisms of the type of Blepharocerid larvae and nymphs of *Iron*, etc. The teeth on both the jaws are sharp and pointed and are directed backwards. Between these two sets of teeth the scraped food has little chance to escape. The gill-rakers are long, broad and pointed, and are closely set; they decrease in size on the posterior gill-arches.

In 1923, I (*op. cit.*, p. 34) expressed the opinion that "*Glyptosternum stoliczkae*" and *G. maculatum* represented the less specialized members of the assemblage denominated as '*Glyptosternum*,' and from the simple nature of the lips and mouth, tooth-bands, gill-openings, paired fins and general facies I was misled to regard them as ancestral forms of Glyptosternoid fishes. Later work[1] has shown that on account of life in deeper and less turbulent waters of the Highlands of Central Asia as compared with those of the small Himalayan streams, *G. reticulatum* has assumed a mask of apparent simplicity and that its simple organisation is the result of retrogression and in no way represents a truly primitive or ancestral condition. These conclusions are borne out by the type of streams in which specimens of *Glyptosternum* were collected by Dr. Chopra in the Chitral Valley.

Local Name.—According to Dr. Chopra *Glyptosternum reticulatum* is known as *Karmatchhi* among the Kafirs.

Schizothorax labiatus (McClelland).

1842. *Racoma labiatus*, McClelland, *Calcutta Journ. Nat. Hist.* II, p. 578, pl. xv, fig. i.
1842. *Schizothorax Ritchieana*, McClelland, *ibid.*, p. 580.
1868. *Racoma labiatus*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 162 (foot-note).
1868. *Schizothorax ritchianus*, Günther, *ibid.*, p. 168.
1877. *Schizothorax Ritchianus*, Day, *Fish. India*, p. 531 (foot-note).
1877. *Schizothorax labiatus*, Day, *ibid.*, p. 532 (foot-note).

McClelland's description and figure of *Schizothorax labiatus*, though meagre and inadequate, are sufficiently clear as regards the most distinctive feature of the species—the nature of the lips. Since McClelland's original account, no observations seem to have been made on *Sch. labiatus*, owing to the fact that no specimen was hitherto available for study. The species was described from Griffith's drawing and the specimens, which were "accidentally left behind with the Ornithological portion of the collection" by Griffith, seem to have been lost in transit. McClelland's characterisation is as follows:

"Length of head greater than depth of body, and equal to a fourth of the entire length. Inter-maxillary very protractile and covered with a thick adipose integument, *a thick trilobed integument to the lower jaw*, cirri terminating in trident points.

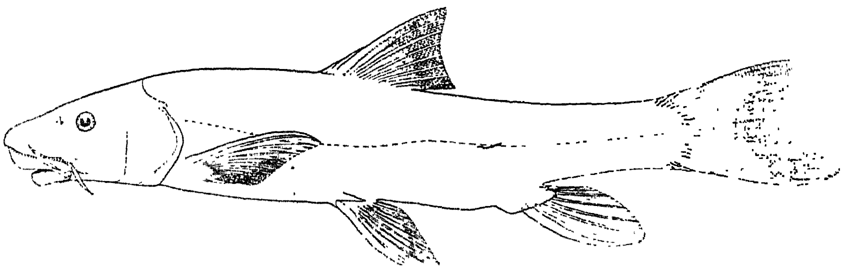
[1] Hora, *Phil. Trans. Roy. Soc. London* (B), CCXVIII, p. 237 (1930).

D. $\frac{3}{8}$: P. 19 : V. 10 : A. 7.

Intestine short, disposed in $3\frac{1}{2}$ or four double folds.

Habitat.—Pashut, Koonar River near Jallalabad.—Griffith's Mss.

Mr. Griffith remarks that this singular form is nearly allied to the Lalpore species, but that the intestines of the latter are infinitely longer, nor is there any enlargement of the lips in the latter; but this last character Mr. Griffith remarks is not so remarkable in young specimens." (Italics are mine).



TEXT-FIG. 1.—Lateral view of a large specimen of *Schizothorax labiatus* (McClelland) from the Pallarga stream (Sta. 2) $\times\frac{1}{4}$.

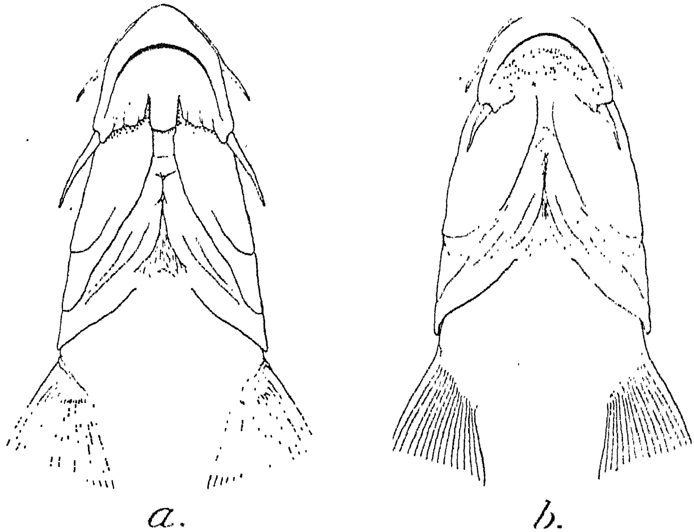
As a rule, in *Schizothorax* the lips are moderately fleshy and it is only in a few characteristic species that they are greatly enlarged. So far as I am aware the lips are hypertrophied in *Sch. regelli* Herz.,[1] of which a single specimen is known from the Amu-Darya, and in *Sch. baileyi* (Lloyd)[2] known from two specimens collected at Gyangtse, Tibet. Whereas in these two species the posterior lip is bilobed, in *Sch. labiatus* it is trilobed and forms a very characteristic feature of the species. In another species—*Sch. ritchieana*—described by McClelland from Afghanistan, the lower lip is trilobed. It is characterized as: "*Reflected posterior margin of the lower lip trilobate*; lips broad, round and soft; width of the mouth equal to about $\frac{1}{2}$ the length of the lower jaw; which is narrow at the apex; snout narrow and compressed; dorsal spine large, scales very small, lateral line raised, body spotted." (Italics are mine). In a large series of specimens collected by Dr. Chopra from the Chitral Valley, there are quite a number of specimens in which the lower lip is greatly enlarged, whereas in the majority of specimens the lips are of the *ritchieana*-type. Moreover, all possible gradations are found in the collection before me between the two types of lips. Fortunately McClelland sent a specimen of *ritchieana* to the Museum at the India House whence it was transferred to the British Museum and later served for Günther's description of the species in the *Catalogue*. The Chitral specimens agree with Günther's description and there seems to me no doubt that *Sch. labiatus* and *Sch. ritchieana* are synonymous. Both

[1] Herzenstein, *Fische*, in *Wiss. Res. Przewalski Central-As. Reis. Zool.*, III, pl. ix, fig. 1. According to Berg (*Poiss. Eaux Douces U. R. S. S.* 3rd Ed., pt. 1, p. 458, 1932), *Sch. regelli* is a synonym of *Sch. fedtschenkoi* Kessler and that the enlarged lips are of the nature of secondary sexual characters of the male. In *Sch. labiatus* both sexes possess enlarged lips.

[2] Lloyd, *Rec. Ind. Mus.*, II, pl. xxv, fig. 2 (1908).

McClelland and Günther observed that in the Helmand River examples the dorsal spine is relatively small. The Chitral collection shows that the dorsal spine is very variable in this species. In certain examples it is strong and well developed, whereas in others it is rather feeble and flexible. But in every case, it is conspicuously serrated posteriorly.

Day included *Sch. labiatus* in the group of species characterized by the "Lower labial fold interrupted", but this is obviously wrong.



TEXT-FIG. 2.—Ventral surface of head and anterior part of body in two specimens of about equal size of *Schizo thorax labiatus* (McClelland) showing variation in size and form of lower lip; etc., × $\frac{2}{3}$.

a. True *labiatus* type; *b. ritchieana* type.

In a number of young specimens it is observed that the condition of lips and jaws is intermediate between *Schizothorax* and *Oreinus*. Such a condition appears to have resulted from hybridisation (*vide infra* p. 307).

McClelland, on the observations of Griffith, stated that *Sch. chrysochlora* has much in common with *Sch. labiatus*. The resemblance is probably closer with the specimens of *Sch. labiatus* in which the lower lip is not well developed. The two species can, however, be readily distinguished by the following features:—

In *Sch. labiatus* the body is more slender and the head is considerably pointed; the labial fold is well developed and prominently trilobed; the commencement of the dorsal fin is almost midway between the tip of the snout and the base of the caudal fin, and the anal scales are very small, considerably less than half the diameter of the eye.

Schizothorax labiatus may be redescribed as follows:—

D. 3/8; A. 3/5; P. 18-20; V. 11-12; C. 20.

Schizothorax labiatus is a narrow, elongated species in which the body is subcylindrical and both the profiles are slightly arched. The ventral

surface of the head and the anterior part of the body are flattish. The head is large and pointed anteriorly; its length is contained 3·7—4·4 times in the total length without the caudal. The width of head is almost equal to its height at the occiput and is contained 1·6—1·7 times in the length of the head. The snout is smooth, but in some specimens it is studded with sharp, wart-like protuberances. These structures are usually characteristic of the males but certain ripe male specimens were without them. The eyes are placed laterally slightly below the dorsal profile of the head and are not visible from the ventral surface; they are situated in the middle of the head or slightly nearer to the tip of the snout than to the posterior margin of the operculum. The diameter of the eye is contained 5·3—7·6 times in the length of the head, 2·1—3·3 times in the length of the snout and 1·7—2·5 times in the interorbital width. The interorbital space is flattish and is marked with a short, longitudinal bony ridge in the middle with two other low ridges on the sides. The mouth is inferior, horizontal and greatly arched; it is bordered by thick and fleshy lips which are continuous at the angles of the mouth. The lower lip is trilobed, the side lobes are free while the middle lobe is only free at the tip. The structure of this lip is subject to great variation as indicated above (*vide supra*, p. 293). The lower jaw is sharp, shovel-like and covered with a thick, horny sheath. There are two pairs of well developed barbels which are longer than the diameter of the eye. The gill-openings are moderately extensive.

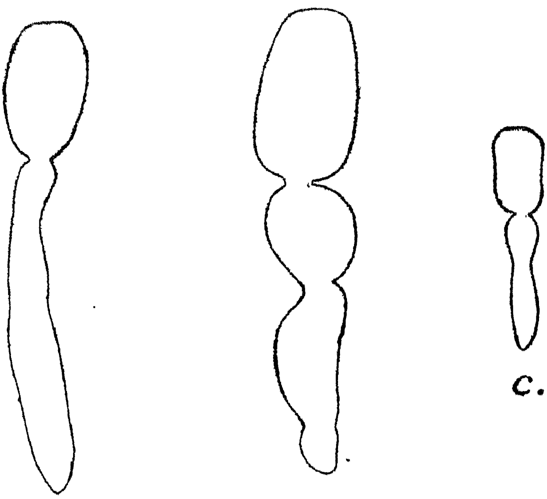
The depth of the body is contained 4·4—5·6 times in the total length without the caudal; it is covered with small scales which are inconspicuous on the ventral surface in front of the ventral fins. The lateral line is slightly raised and there are about 107 scales along it and 28 rows between it and the base of the dorsal spine. The tiled row of anal scales is rather indistinct; the largest scale being less than half or about half the diameter of the eye.

The commencement of the dorsal fin is opposite to that of the ventral and is almost equidistant between the tip of the snout and the base of the caudal fin. The dorsal spine is strong and horny or feeble; its length in middle-sized specimens is contained 1·0—1·2 times in the length of the head. In older specimens the spine is proportionately shorter, its length being contained 1·6 times in the length of the head. The spine is strongly serrated posteriorly. The posterior margin of the dorsal fin is slightly emarginate. The pectoral fin is shorter than the head and its outermost ray is the longest; it is separated from the ventral by a considerable distance. The anal opening is situated at the base of the anal fin and is considerably removed from the ventral fin. The anal fin, when laid flat, does not reach the caudal fin. The caudal fin is deeply emarginate. The caudal peduncle is strong and muscular; its least height is contained 1·5—1·9 times in its length.

In very young specimens the body is marked with short, black streaks. In half-grown and adult specimens the body is uniformly silvery with a slightly darker tint on the dorso-lateral surface of the body.

Air-bladder.—The air-bladder of *Schizothorax labiatus* shows considerable variation as regards the form of the posterior chamber. In adult examples the walls of the bladder are thickened, fibrous and

inelastic. The anterior chamber is of the normal Cyprinoid form, whereas the posterior chamber is long and narrow. In one specimen the posterior chamber was found to be constricted in two places asymmetrically so that the bladder appeared four chambered. In a young specimen the posterior chamber was slightly narrowed in the middle. Similar variations also occur in the bladder of *Oreinus sinuatus* var. *griffithii*. The significance and the probable mode of origin of these abnormal types of bladders are discussed below (*vide infra*, p. 304).



a. b. c.

TEXT-FIG. 3.—Air-bladders of 3 specimens of *Schizothorax labiatus* (McClelland) showing variation in form and structure. × ⅜. The thickness of the lines roughly indicates the thickness of the walls of the different chambers.

a. Normal type; from a specimen 350 mm. in length.
b. An abnormal four-chambered air-bladder from a specimen 325 mm. in length.
c. Air-bladder of a young specimen 160 mm. in length.

Distribution and Habitat.—*Schizothorax labiatus* was described from the Kunar River near Jallalabad, but the form *ritchieana* was stated to be fairly common in Afghanistan. Dr. Chopra's collection shows that the species is very common in the Chitral River and its tributaries. Specimens were obtained from the following localities :—

(i) 1 large specimen from the Pallarga stream, 2 miles below Kunisht in the Rambhur Valley (Sta. 2).
(ii) 6 specimens collected at Chitral in August 1929.
(iii) 47 specimens from the Lutkuh River at Sheghor (Sta. 8).
(iv) 1 specimen from the Lutkuh River near Hot Springs (Sta. 9).
(v) 21 specimens from the Mastuj River between Koghzai and Mastuj (Sta. 12).
(vi) 28 very young specimens from a small stream between Tar and Drosh.
(vii) 11 specimens from Ramram gol near its junction with the Chitral River below Arandu (Sta. 16).

The larger individuals were obtained from rivers with swift current and rocky bed whereas the young specimens were collected in small streams. In young specimens the character of the lower lip is not so well developed as has already been remarked by Griffith. Both *Oreinus* and *Schizothorax* prefer large rivers with or without backwaters; the former is confined to these habitats whereas the latter occurs in lakes also. *Schizothorax* lives in rapids under stones and rocks.

Bionomics.—In young specimens the alimentary canal is about 1·5 times the total length of the fish and in a specimen about 300 mm. in length it was 2·3 times the length. The stomach was empty in most of the specimens dissected which suggests not only that feeding is intermittent but that the digestive action is fairly rapid. The alimentary canal was full of grayish pulp and pieces of gravel. It seems likely that *Schizothorax* feeds on caddis-worms, algae and insect larvae. The shorter length of its intestine shows that it is more carnivorous in its feeding habits than *Oreinus*. It seems likely that the broad lips of *Sch. labiatus* are spread out and applied to rocks for adhesive purposes. The horizontal paired fins and the flattish ventral surface are no doubt used for this purpose. The pointed and subcylindrical body of the fish is well adapted to offer less resistance to the rushing currents.

Measurements in millimetres.

Total length excluding caudal	184·5	215·0	243·0	262·0	350·0
Length of caudal	41·0	53·0	57·0	55·5	78·0
Length of head	42·5	51·0	58·3	59·0	93·0
Width of head	25·0	29·2	37·0	35·0	57·0
Height of head at occiput	26·5	30·3	37·8	37·0	54·0
Length of snout	17·0	21·0	23·0	26·0	41·3
Diameter of eye	8·0	8·0	10·0	8·4	12·2
Interorbital width	13·5	16·0	21·0	20·3	30·5
Depth of body	37·6	37·8	55·0	53·0	68·5
Length of dorsal spine	38·3	41·0	47·0	50·0	56·0
Length of pectoral	31·4	40·0	43·2	46·0	67·3
Length of ventral	30·6	37·6	41·5	42·0	63·0
Length of caudal peduncle	19·0	21·6	30·0	28·0	36·8
Least height of caudal peduncle	40·5	40·0	46·0	52·0	66·7

Schizothorax esocinus Heckel.

1838. *Schizothorax esocinus*, Heckel, *Fische aus Caschmir*, p. 48, pl. ix.
1842. *Schizothorax esocinus*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 579.
1844. *Schizothorax esocinus*, Heckel, *Fische Kaschmir*, p. 372, 3 figs.
1868. *Schizothorax esocinus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 166.
1876. *Schizothorax esocinus*, Day, *Proc. Zool. Soc. London*, p. 785.
1876. *Schizothorax punctatus*, Day, *ibid.*, p. 785.
1877. *Schizothorax esocinus*, Day, *Fish. India*, p. 533, pl. cxxiii, fig. 4.
1877. *Schizothorax punctatus*, Day, *ibid.*, p. 532, pl. cxxiii, fig. 3 (foot-note).
1878. *Schizothorax esocinus*, Day, *Sci. Res. 2nd Yarkand Miss.*, Ichthyology, p. 4, pl. i, fig. 4.
1878. *Schizothorax punctatus*, Day, *ibid.*, p. 4, pl. 1, fig. 3.
1889. *Schizothorax esocinus*, Day, *Faun. Brit. India, Fish.*, I, p. 254.
1889. *Schizothorax punctatus*, Day, *ibid.*, p. 252 (foot-note).
1910. *Schizothorax esocinus*, Zugmayer, *Zool. Jahrb.*, XXIX, p. 277.
1916. *Schizothorax esocinus*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (3), VII, p. 20.

Both Zugmayer and Vinciguerra have referred at some length to the discrepancies in Day's descriptions, and to the inaccuracies in his drawings of *Schizothorax punctatus* and *Sch. esocinus*. From an examination of specimens in their possession they came to the conclusion that the two species are identical. The Zoological Survey of India possesses the originals of Day's figures of these two species, and a comparison of the specimens shows that Day, who probably did not possess a large series of specimens of *Sch. esocinus* to study its range of variation, had some justification to regard them as belonging to two species. Besides the differences in the general facies of the two specimens clearly shown in Day's delineations, they differ in the form and proportion of the head, the nature of the jaws, the extent and form of the mouth opening and the way in which the bones of the hyoid arch lie on the ventral surface of the head. The following table of measurements shows some of the salient differences between the two specimens :—

Measurements in millimetres.

	Sch. esocinus. (No. 678).	*Sch. punctatus.* (No. 511).
Total length excluding caudal	170·5	192·0
Length of head	46·0	59·5
Width of head	23·0	26·3
Height of head at occiput	23·7	30·0
Greatest diameter of eye	8·0	10·2
Interorbital width	13·2	19·3
Length of snout	15·5	20·8
Depth of body	32·2	34·2
Length of rostral barbel	10·0	9·0
Length of maxillary barbel	12·0	8·0
Length of caudal peduncle	30·0	35·0
Least height of caudal peduncle	16·0	17·2

Day's illustrations are inaccurate in several respects and it seems probable that he drew up his descriptions from the figures without reference to the specimens, otherwise it is not possible to believe how his descriptions could be so faulty and misleading. *Schizothorax esocinus* seems to vary considerably and when a number of specimens are examined the differences noted above between the two forms are bridged over. Sufficient material is not available to decide whether these differences are in any way related to the sexes of the individuals. Berg[1] has indicated that in the case of *Sch. fedtschenkoi* Kessler there may be great structural differences between the two sexes.

Griffith obtained specimens of *Sch. esocinus* in the tributaries of the Helmand and the Kabul Rivers in Afghanistan. In the Chitral Valley the fish is said to be very rare ; it is represented by a single specimen which was collected by Dr. Chopra from the Chitral River near the Chitral town. Dr. Chopra informs me that he made special efforts to obtain more specimens of this species but without any success. This example represents the typical *esocinus* of Day and in it the length of the head is

[1] Berg, *Abhandlungen der Pamir Expedition* 1928, VIII, p. 23, pl. ii, figs. 1 and 2.

contained 3·6 times in the total length without the caudal. The height of the head at the occiput is almost equal to the width of the head which is nearly half the length of the head. The diameter of the eye is contained 6·5 times in the length of the head, 2·2 times in the length of the snout and 1·9 times in the interorbital width. This specimen is about 275 mm. in length, but Dr. Chopra was informed that the species grows to a much larger size and is a very good eating fish. In comparison, it is considered to be a better fish for eating than other species of *Schizothorax* and *Oreinus* commonly met with in Chitral. In spite of its qualities of flesh, the local people consider it a foul feeder. The stomach contents of the Chitral example consist of a semi-digested young specimen of *Schizothorax* and plenty of dark-coloured gravel and sand. It is likely that this species lives in pools and puddles where it feeds on dead animal matter deposited at the bottom. Its jaws are somewhat protrusible so that it can probe about in the mud and suck in food mixed with gravel like some of the typical Cyprinid fishes. Enough material is not available, however, to make any detailed observations on the bionomics of this species.

Besides the specimens referred to above there are five other examples of *Schizothorax esocinus* from Kashmir in the collection of the Zoological Survey of India. These specimens were obtained in June-July 1921 by the Kashmir Survey Party. Of these, 3 comparatively young specimens up to 135 mm. in total length were obtained in the Jhelum River at Srinagar, one from Wular Lake and a large one from Gandarbal. These specimens show that the head is relatively longer in younger individuals; its length being contained 3·3—3·6 times in the total length without the caudal. The depth of the body is very variable, being contained 4—5·6 times in the length without the caudal. The eyes are relatively much larger in the young specimens; the diameter of the eye is contained 4·5—7·6 times in the length of the head, 1·5—2·5 times in the length of the snout and 1·2—2·1 times in the interorbital width. The caudal peduncle is narrower and longer in larger specimens, the least height of the caudal peduncle is contained 1·7—2·1 times in its length. The fins are nearer to one another in young specimens whereas in grown-up individuals they are situated more widely apart. The osseous and serrated ray of the dorsal fin is always longer than the postorbital part of the head; it is proportionately longer in the young specimens. The longest ray of the dorsal fin is contained 1·2—1·7 times in the length of the head. The young specimens are generally marked with largish black spots, while the larger specimens are covered with numerous black marks. The example from Chitral as well as the smallest specimen from Kashmir are without any marking. They are grayish above and silvery on the sides and below.

Remarks.—In describing *Schizothorax punctatus* Day referred to "*Racoma nobilis* McClelland" (*op. cit.*, p. 577), and remarked that it "has more fleshy lips, while the mouth appears more transverse, as in *Oreinus*, and the under jaw much the shorter". McClelland had no specimen of the species, but described it from Griffith's drawing. Day's remarks are also based on this illustration. *Schizothorax nobilis* is said to grow to a large size (18 inches) and its habits of preying on small fish

and feeding on offal show that it may prove to be identical with *Sch. esocinus.* Its body and fins are covered with spots as is usually the case in *Sch. esocinus.*

In the following table I give the measurements of the Chitral example as well as of the five specimens from Kashmir :—

Measurements in millimetres.

	Chitral.	Jhelum River.			Wular Lake.	Gandarbal.
Total length without caudal	224·2	95·0	107·3	110·3	191·0	273·0
Length of head	62·2	28·5	32·0	33·0	54·0	76·5
Width of head	31·5	13·3	18·3	16·3	26·0	39·5
Height of head	31·3	15·2	19·0	18·0	31·0	41·6
Diameter of eye	9·5	6·0	7·0	6·0	8·0	10·0
Length of snout	21·6	9·0	10·8	10·4	18·6	25·0
Interorbital width	18·5	8·0	8·8	8·2	14·0	21·0
Depth of body	43·5	20·3	26·8	23·3	37·5	48·0
Longest ray of dorsal	38·0	20·2	23·0	27·2	32·0	42·5
Longest ray of anal	34·0	15·1	18·3	20·3	27·2	40·0
Length of pectoral	38·2	16·6	18·8	19·2	29·0	39·2
Distance between pectoral and base of ventral.	25·5	11·6	13·3	14·0	23·0	34·3
Length of ventral	35·5	15·7	17·2	20·0	26·2	37·0
Distance between ventral and base of anal.	17·0	7·3	10·5	8·0	21·2	26·5
Length of caudal peduncle	41·0	15·7	19·0	18·7	31·0	52·0
Least height of caudal peduncle	23·5	9·0	11·0	11·0	17·0	24·0

Oreinus sinuatus var. **griffithii** McClelland.

1842. *Oreinus Griffithii*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 581.
1842. *Oreinus maculatus*, McClelland, *ibid.*, p. 580.
1868. *Oreinus griffithii*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 160 (foot-note).
1868. *Oreinus sinuatus*, Günther (in part), *ibid.*, p. 161.
1933. *Oreinus sinuatus* var. *griffithii*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 700.
1934. *Oreinus sinuatus* var. *griffithii*, Hora, *ibid.*, XXXVII (in press).

In his account of the fish of Afghanistan in Griffith's collection, McClelland recorded specimens of the genus *Oreinus* from the head of the Ali Musjid stream (Khyber Pass), Kabul River, Gandamak, Pashat and Girdun Dewar. The examples from the Helmand River (Girdun Dewar) were referred by him to *O. plagiostomus* Heck., while those collected at Pashat (Kunar River) were described as *O. griffithii.* The young specimens obtained in the Kabul River, Ali Musjid stream and at Gandamak were designated *O. maculatus*, a species described by McClelland from the Simla Hills. From Günther's *Catalogue* it appears that no specimen of *O. griffithii* passed into the collection of the British Museum and consequently Günther could not define its exact specific limits as the description is meagre and defective. The species was, therefore, referred to in a foot-note as a doubtful form. *O. plagiostomus* was characterized by Günther on Afghanistan specimens (1 stuffed adult from Jallalabad and skins of one adult and one half-grown from Helmand River), while McClelland's young specimens of *O. maculatus*

from Gandamak were referred by Günther to *O. sinuatus.* Day in the *Fishes of India* (pp. 529-531) followed Günther's views, but in referring to *O. griffithii* under the description of *O. plagiostomus* made the following remark: *O. griffithii* " is said to differ but little from the above, its intestine are six times the length of the body, its *habitat* is Afghanistan, Koonur river, Pushut ". It would thus appear that since the publication of the description of *O. griffithii* McClelland, it has not been possible for later workers to elucidate its exact systematic position. This was due to the fact that so far no specimens of the species were available for examination.

Dr. Chopra obtained a large series of specimens of a species of *Oreinus* in the Chitral Valley and though it differs but little from *O. sinuatus*, there are features which, in the present state of our knowledge of the genus, warrant separation of the two forms. Fortunately specimens have also become available from the Paghman River and Sir-i-Chashma (Kabul River) for comparison and these have made it clear that the Chitral *Oreinus* is also found extensively in the Kabul River and its tributaries in Afghanistan. It may be mentioned that Kunar River (or Chitral River), the type-locality of *O. griffithii,* is the principal river of the Chitral Valley whence Dr. Chopra obtained abundant material of the species.

Oreinus griffithii was briefly characterized by McClelland as follows: " The breadth of the mouth is equal to half the length of head, and of the interval from the extremity of the snout to the commencement of the pectorals. Dorsal spine large, vertical scales at the anal obsolete, posterior margin of the operculum round, snout smooth.

D. $\frac{4}{8}$: P. 20 : V. 11 : A. $\frac{1}{6}$: C. 19.

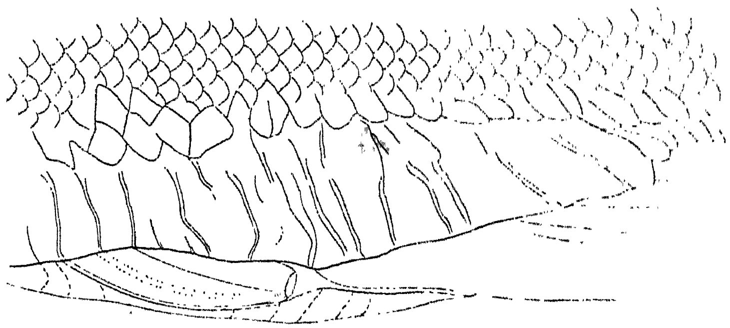
The intestines are six length of the body, and contain a brownish pulp. (Griffith.)

This species although perfectly distinct, differs but little in appearance from Oreinus plagiostomus.

Habitat.—Afghanistan, Koonur river, Pushut. (Griffith.) "

The reference to *O. plagiostomus* in the above description seems to have been partly responsible for our ignorance of *O. griffithii.* According to McClelland, the breadth of the mouth of *O. plagiostomus* " is equal to a third of the length of the head, and of the interval from the extremity of the snout to the pectoral fins " ; the dorsal spine is " slender and soft " and the " vertical scales at the base of the anal are rather large ". Günther's and Day's descriptions of *O. sinuatus,* to which *O. griffithii* is closely allied, and of *O. plagiostomus* show that the main differences between the two species lie in the character of the dorsal spine and the size of the anal scales. In the Schizothoracinae these characters are of great diagnostic value and are usually employed in distinguishing genera. Judging by these features, most of the specimens in Dr. Chopra's collection agree with *O. sinuatus* but there are two specimens, one 260 mm. long without the caudal from Pallarga stream in the Rambhur Valley and

the other 325 mm. long without the caudal from the Mastuj River between Koghazi and Mastuj, in which the anal scales are well developed and are as large as or larger than the diameter of the eye. The dorsal spine is of the nature so characteristic of *O. sinuatus*, and in other respects also they correspond with the remaining specimens. It is not possible to account for this variation as there are no gradations in the large series before me, and in the present state of our knowledge it would be better to consider them as abnormalities.



TEXT-FIG. 4.—Enlarged anal scales of a specimen of *Oreinus sinuatus* var. *griffithii* McClelland from the Pallarga stream. ×2. The scales are very thin and their outlines are not well defined.

It has been indicated above that *O. griffithii* very closely resembles *O. sinuatus* in its general facies, but differs in having somewhat finer serrations on the dorsal spine, in the shorter length of the spine and in the fact that all the fins, especially the anal, are shorter. The vertical anal scales are obsolete in *O. griffithii*, with the exception of the two specimens noted above, whereas in *O. sinuatus* the scales, though small, are fairly well marked and distinct. In view of these differences it seems desirable to treat *O. griffithii* as a distinct form, for the time being at least, and at the same time to express its close affinity to *O. sinuatus*. For these reasons, I have regarded *griffithii* as a variety of *sinuatus*.

There can be hardly any doubt that *Oreinus* is a specialized form of *Schizothorax* and that the evolutionary steps by which this modification has been brought about are not very difficult to comprehend. In fact, it is very difficult to distinguish the young of *Oreinus*, at least in the earlier stages, from those of *Schizothorax*. This difficulty is further augmented by a hybridization between *Schizothorax* and *Oreinus* which, as Dr. Chopra's collection shows, is a very common occurrence in nature and results in the production of forms intermediate between *Schizothorax* and *Oreinus*. I refer to this phenomenon later (*vide infra* p. 307). In the light of the above observations, McClelland's remarks regarding *O. maculatus* that "it is an intermediate form between Schizothorax and Orienus" is readily understood. According to McClelland, *O. maculatus* "seldom exceeds six inches in length" and is, therefore, a young form. There are several young specimens of *O. griffithii* in Dr. Chopra's collection which agree with *O. maculatus*, both in general

features and colouration. I have no doubt, therefore, that *O. maculatus* is a synonym of *O. sinuatus* and that both Günther and Day were justified in this conclusion.

The Kabul River form, *O. sinuatus* var. *griffithii*, may be redescribed as follows :—

D. 3/8 ; A. 3/5 ; P. 21 ; V. 10 ; C. 20.

Oreinus sinuatus var. *griffithii* is a strong and muscular fish in which the body is subcylindrical and both the profiles are somewhat arched. The ventral surface of the head and the anterior part of the body are flattish. The head is short and bluntly pointed ; its length is contained 4·1—5·0 times in the total length without the caudal. In the young specimens, the head is proportionately larger, but during growth the other parts of the body develope more vigorously so that in larger examples it is about one-fifth of the length without the caudal. The head is almost as broad as deep at the occiput ; the width of the head is equal to its length behind the anterior nostrils. The snout is usually smooth but in a number of half-grown and adult specimens it is covered with warts. These structures seem to characterize male specimens. The eyes are, for the most part, in the anterior half of the head ; they are lateral in position but their upper margin is slightly below the dorsal profile of the head and they are not visible from the ventral surface. The eyes are proportionately larger in young specimens ; their diameter is contained 4·1—6·7 times in the length of the head ; 1·3—2·5 times in the length of the snout and 1·3—2 times in the interorbital width. The interorbital space is broad and flat. The mouth is inferior, transverse and slightly arched ; the width of the mouth is somewhat greater than half the width of the head. The lips are fleshy and continuous ; the upper lip covers the jaw and is simple, the lower lip is reflected from the jaw and is papillated. The exposed portion of the lower jaw is sharp and enclosed in a thick horny sheath. There are two pairs of small barbels. The gill-openings are moderate and extend to the ventral surface for a considerable distance.

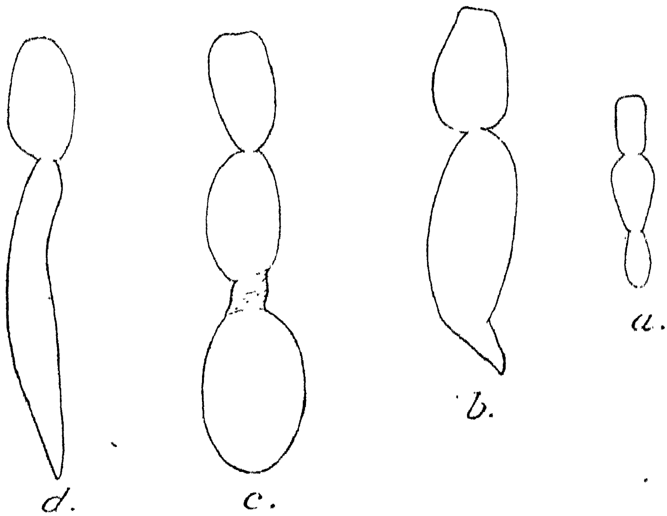
The depth of the body is contained 4·7—5·3 times in the length without the caudal ; it is covered with small scales, about 110 along the lateral line and 28 between it and the base of the dorsal spine. The lepidosis is irregular. The tiled row of anal scales is indistinct, the largest scale being much less than half the diameter of the eye. The lateral line is slightly curved but it runs to the middle of the base of the caudal fin.

The dorsal fin commences in advance of the ventral and is nearer to the tip of the snout than to the base of the caudal fin ; the dorsal spine is long and strong and is serrated with moderate spines posteriorly ; it is not as long as the head and possesses a thin, flexible portion which is equal to the diameter of the eye. The posterior margin of the dorsal fin is slightly emarginate. The paired fins are horizontally placed and their outer rays are the longest. The pectoral fin is shorter than the head and is separated from the ventral by a considerable distance.

The ventral fin is considerably removed from the anal. The anal opening is situated just in front of the anal fin, which, when laid flat, is separated from the caudal fin by a considerable distance. The caudal fin is deeply emarginate ; the lower lobe is better developed than the upper. The caudal peduncle is strong and muscular ; its least height is contained 1·6—1·9 times in its length.

In young specimens the upper part of the body is marked with short, black streaks characteristic of *Oreinus maculatus*. The ground colour is grayish above and pale white below. In half-grown and adult specimens, the black markings disappear and the fish takes on a silvery hue. On this account it is usually known as " snow-trout ".

Air-bladder.— When dissecting specimens to examine the stomach contents, I found a great range of variation in the structure and form of the air-bladder in *O. sinuatus* var. *griffithii*. As the air-bladder is a character of great diagnostic value in the taxonomy of Cyprinoid fishes, it is necessary to make a few observations on the condition of the organ in the specimens before me.



TEXT-FIG. 5.—Air-bladders of 4 specimens of *Oreinus sinuatus* var. *griffithii* McClelland showing variation in form and structure. $\times \frac{2}{3}$. The thickness of the lines roughly indicates the thickness of the walls of the different chambers.

a. Three-chambered bladder of a young specimen 110 mm. long.
b. Air-bladder of a specimen 225 mm. long showing modification of the posterior chamber at the hinder end.
c. Three-chambered bladder of a specimen 265 mm. long. Notice the broad collar separating second and third chambers.
d. Normal type of air-bladder in an adult specimen. Notice the posterior chamber is narrow, elongated and thick walled and has not the form and structure of the normal bladder of the Cyprinoid fishes.

In a young specimen about 110 mm. long, the air-bladder is almost tripartite ; the anteriormost chamber possesses somewhat thick walls,

the middle chamber is moderately thick-walled while the small, third chamber is thin-walled. The pneumatic duct opens between chambers one and two. At the constriction between the middle and the last chamber, the skin is specially thick. This tripartite condition is better marked in the bladder of another specimen (fig. 5 *c.*) about 265 mm. in length. Here instead of a constriction between chambers two and three, there is a definite collar of very thick skin while the last chamber is very thin walled. Normally in these fishes the air-bladder is bipartite, as is characteristic of the Cyprinidae. Owing to life in rapid waters and in consequence of a ground habit, the air-bladder is not much used as a hydrostatic organ and its walls become thick and inelastic (fig. 5*a*). The lumen decreases and the bladder becomes greatly reduced in size. It has been shown in the case of other genera[1] that the reduction and solidification of the bladder starts with the posterior chamber. In *griffithii* also probably the same process takes place. In a specimen 225 mm. in length, the end portion of the posterior chamber of the bladder was found to be thin and pointed and had very thick walls (fig. 5 *b*). Evidently the solidification of posterior chamber had started in this specimen at the right place and in course of time the bladder would have assumed the normal form as shown in figure 5*d*. The tripartite condition of the bladder in this species is certainly abnormal and, in my opinion, is produced by the thickening of the skin of the middle part of the posterior chamber instead of its hindermost part. In any case such a condition is not of any great importance for taxonomic purposes. I have shown elsewhere [2] that the bladder of hill-stream fishes is greatly reduced as they invade swifter and swifter currents and that if they happen to revert to deeper waters, a structure similar to the original bladder makes its appearance for hydrostatic purposes. Thus there is a close correlation between the structure of the bladder and the habitat of the fish. In fishes that live in rapid, but relatively deeper waters, the structure of the bladder must be very variable as has been shown above in the case of *Oreinus*.

Tchang,[3] in establishing his genus *Parosteobrama* has observed that " vessie natatoire en 3 parties, la' premiere, ovale et arrondie aux deux bouts, la deuxieme plus longue que la premiere, la troisieme tres petite ". Unfortunately no figure is published but the description indicates a structure similar to the one figured here as 5*b*. It is probable that the so-called third chamber of *Parosteobrama* represents the area where the bladder has started to acquire thick walls. It should also be borne in mind that *Rohtee* (=*Parosteobrama*) is a genus of clear-water streams and though it is not found in very swift currents, it is always subject to sudden rush of waters. Such a habitat also denotes a varying environment. Mukerji[4] has shown that normally there are only two chambers in *Rohtee*. In *R. pelligrini* the third chamber may be only a modified portion of the second as stated above.

[1] Hora, *Journ. As. Soc. Bengal* (N. S.) XVIII, pp. 5-7 (1922).
[2] Hora, *Journ. Bombay Nat. Hist. Soc.* XXXIV, pp. 374-385 (1930).
[3] Tchang, *Bull Soc. Zool. France* LV, pp. 46-52 (1930).
[4] Mukerji, *Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 69 (1934).

Distribution and Habitat.—*Oreinus sinuatus* var. *griffithii* has so far been recorded from the Kabul River and its tributary streams. It was originally described from the Kunar or Chitral River. The species is well represented in the Chitral Valley whence Dr. Chopra collected specimens from the following localities :—

(i) 38 specimens from the Pallarga stream, 2 miles below Kunisht in the Rambhur Valley (Sta. 2).
(ii) 21 specimens from the Bumboret River between Daimali and Karakal in the Bumboret Valley (Sta. 7).
(iii) 86 specimens from the Lutkuh River near Uts or Hot Springs (Sta. 9).
(iv) 14 specimens from the Mastuj River between Koghazi and Mastuj (Sta. 12).
(v) 22 young specimens from a small stream near Surguz (Sta. 13).
(vi) 11 specimens from a small stream between Tar and Drosh (Sta. 15).
(vii) 12 specimens from Ramram gol near its junction with the Chitral River below Arandu (Sta. 16).
(viii) 28 specimens collected at Chitral in August 1929.

The larger specimens were obtained from rivers with rocky beds and fast currents, while the young ones were collected from small streams generally containing vegetation or with a sandy bed. It seems probable that the small streams form the nurseries where larger fish resort to for breeding purposes. Most of the young specimens appear to be intermediate between *Schizothorax* and *Oreinus*, and it seems likely that some of them are hybrids. I have discussed the affinities of such specimens below. According to Dr. Chopra's observations the species lives under stones and rocks.

Bionomics.—The alimentary canal of *O. griffithii* is greatly convoluted and is about 2·6 times the total length of the fish. As has already been observed by Griffith, it contains a brownish pulp, but in one case both the stomach and the intestine were full of sand and gravel. The structure of the lips and jaws shows that the fish adheres to smooth rocks and scrapes off algal matter which, no doubt, forms its principal food. Its horizontal paired fins, flattish ventral surface and the papillated lower lip are modified for the purpose of adhesion ; whereas its subcylindrical body is adapted to offer the least resistance to rushing currents. During floods in the Bumboret River, a few specimens of *griffithii* were washed ashore ; but the mortality among this species was not so high as in *Glyptosternum reticulatum*. *Oreinus* is a powerful swimmer and can dart from rock to rock with great rapidity. It prefers to live among rocks on the sloping side of a rapid over which water rushes with great speed.

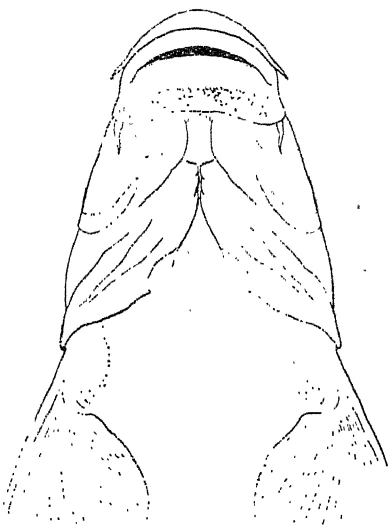
Local Name.—According to Dr. Chopra, *O. sinuatus* var. *griffithii* is known as *Omatchhi* among the Kafirs.

Measurements in millimetres.

	Specimens with enlarged anal scales. Sta. 2.	Sta. 12	Sta. 2.		Sta. 12.		Sta. 9.	
Total length excluding caudal	325·0	260·0	168·0	102·0	122·0	103·0	265·0	255·0
Length of head	64·0	52·0	38·0	22·0	27·0	25·0	52·0	52·0
Width of head	43·0	33·0	24·0	14·5	17·0	14·0	36·0	35·0
Height of head	43·0	33·0	24·0	14·5	19·0	16·5	34·0	34·0
Diameter of eye	10·0	8·0	7·0	4·5	6·0	6·0	9·0	9·0
Length of snout	25·0	18·0	14·0	9·0	9·0	8·0	20·0	17·0
Interorbital width	20·0	16·0	10·0	6·0	9·0	8·0	16·0	15·0
Depth of body	66·0	49·0	33·0	20·0	25·0	22·0	55·0	53·0
Length of dorsal spine	45·0	41·0	29·0	18·0	22·0	22·0	42·0	38·0
Longest ray of anal	60·0	39·0	27·0	15·0	21·0	19·0	43·0	38·0
Length of pectoral	64·0	43·0	32·0	19·0	21·0	20·0	45·0	43·0
Distance between pectoral and base of ventral.	35·0	30·0	12·0	9·5	10·0	8·0	25·0	26·0
Length of ventral	58·0	40·0	28·0	17·0	20·0	19·0	41·0	39·0
Distance between ventral and anal	30·0	24·0	9·0	6·0	6·0	6·0	16·0	18·0
Length of caudal peduncle	60·0	42·0	22·0	13·0	16·0	14·0	46·0	42·0
Least height of caudal peduncle	35·0	30·0	17·0	10·0	13·0	10·0	32·0	30·0

? **Schizothorax labiatus × Oreinus sinuatus** var. **griffithii.**

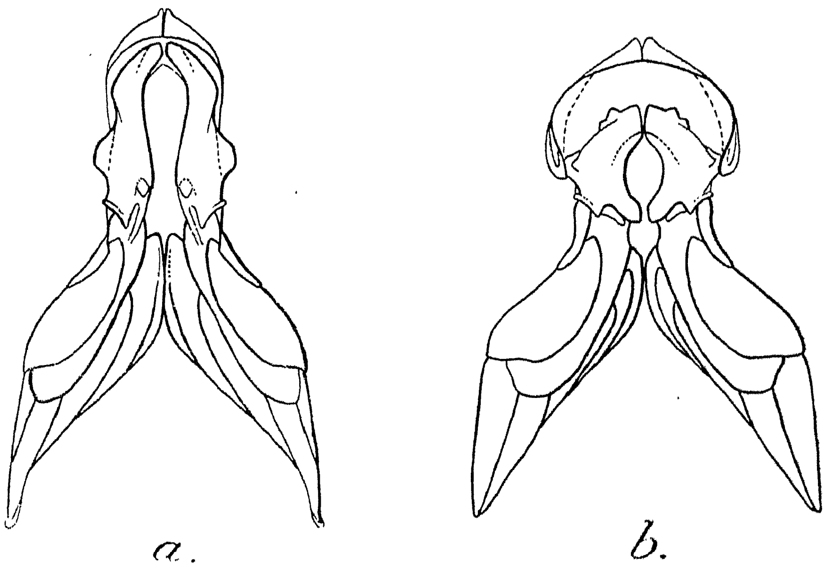
References have already been made (*vide supra*, pp. 294, 302) to the fact that in Dr. Chopra's collection there are several young and half-grown specimens in which the structure of the lips and jaws is interme-



TEXT-FIG. 6.—Ventral surface of head and anterior part of body of *Oreinus sinuatus* var. *griffithii* McClelland showing the nature of lips and jaws.

diate between *Schizothorax* and *Oreinus*. In fact, all possible gradations exist between the *Schizothorax* and the *Oreinus* types of mouth,

I have also no doubt that *Oreinus* is a more specialised form of *Schizothorax* and that it is better adapted to live in swifter currents. The modifications of the lips and jaws are clearly indicative of such a specialisation. The two genera are very closely related, the main difference being that in *Oreinus* the broad, short and flat mandibles are loosely joined together. The anterior margin of the lower jaw is exposed and is covered with a thick horny sheath. The lower lip forms a papillated, broad band behind the naked portion of the jaw and is probably used for adhesion. In conformity with the bony structures mentioned above the head is short, flat and depressed in *Oreinus*, while it is elongated and narrow in *Schizothorax*.



TEXT-FIG. 7.—Skeleton of the lower jaw and associated structures of *Schizothorax* and *Oreinus* in ventral view. $\times 1\frac{1}{2}$.

a. Schizothorax labiatus (McClelland).
b. Oreinus sinuatus var. *griffithii* McClelland.

A few selected stages between the *Schizothorax* and the *Oreinus* types of mouth-parts may be described here.

(*a*) Total length 148 mm. Length of head 34 mm.

The central lobe of the lower lip is much narrower otherwise it is similar to that of *Schizothorax labiatus*.

(*b*) Total length 131 mm. Length of head 31 mm.

The structure of the lips and the associated parts is not very different from that of the typical examples of *Schizothorax labiatus*.

(*c*) Total length 141 mm. Length of head 31 mm.

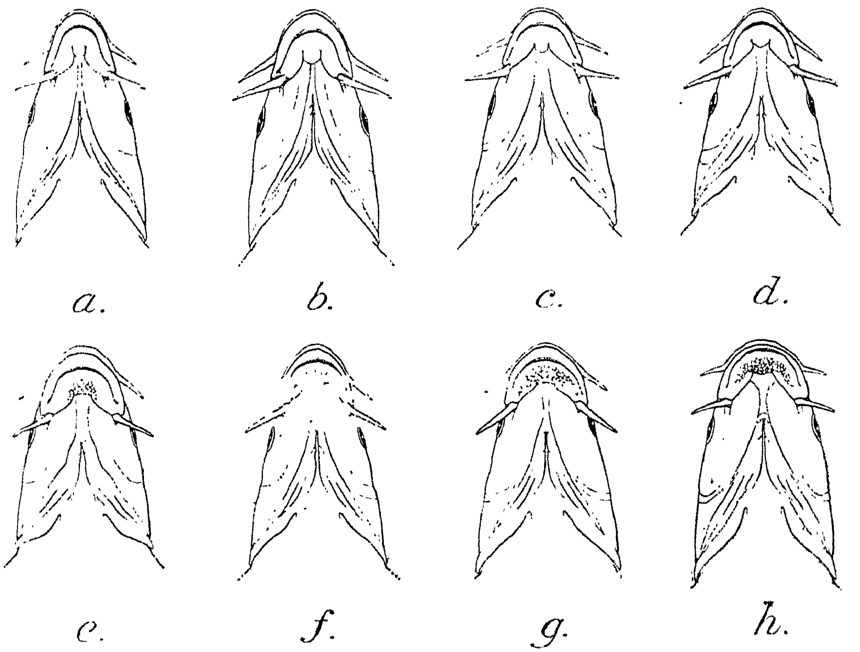
The mandible has become somewhat shorter and broader and the central lobe of the posterior lip is slightly reduced.

(*d*) Total length 153 mm. Length of head 34 mm.

The posterior lip is still further modified and the snout is considerably broad.

(*e*) Total length 137 mm. Length of head 30 mm.

The head has assumed the *Oreinus* form though the structure of the lips and jaws is not of the *Oreinus* type yet. The central lobe of the posterior lip has disappeared and its middle part has become papillated. The barbels are somewhat shorter.



TEXT-FIG. 8.—Ventral surface of head in eight specimens intermediate between *Schizothorax* and *Oreinus* in regard to the nature of the lips and jaws and the form of the head. All figures are more or less of natural size.

a-d represent retrogressive modifications in the *Schizothorax labiatus* type of mouth-parts, while e-h represent progressive modifications towards the formation of an *Oreinus* type of mouth-parts.

(*f*) Total length 128 mm. Length of head 30 mm.

The head is more or less of the *Schizothorax* type but the lips are considerably modified. The posterior lip is papillated.

(*g*) Total length 145 mm. Length of head 34 mm.

The head is not so broad as in *Oreinus* but the extent of papillae on the lower lip is considerably greater.

(*h*) Total length 141 mm. Length of head 32 mm.

The head is of the *Oreinus* type and the posterior lip is papillated. The most remarkable feature of this specimen is that the mouth is situated only slightly behind the tip of the snout.

It is clear from the measurements given above that the various modifications are not correlated with size.

When determining the collection from Chitral these intermediate forms proved very troublesome, for it was noticed that in the normal young of *Oreinus* the characters of the genus were present in earlier stages of development and they could readily be referred to *O. sinuatus* var. *griffithii*. Similarly the lip character of *Schizothorax labiatus* is also marked at an early stage. After a great deal of consideration I can suggest two possibilities for the occurrence of these intermediate forms. They are either the young of *Oreinus* which have not shaken off the ancestral characters of *Schizothorax* or they represent hybrids between the two common 'Barbels' of the Chitral Valley. The latter supposition seems to be more justified, for intermediate forms occur in great abundance. Even Griffith and McClelland noticed their presence in Afghanistan. Hybridisation among fishes in nature is not a rare occurrence, and several instances have been figured and described by Berg from Central Asia. Both *Oreinus* and *Schizothorax* live in large, rapid-water rivers and prefer a more or less similar habitat- the rocks of the rapids in the course of streams. If the breeding period of the two Chitral species were to coincide at any place, there is a liklihood of the production of a large number of hybrids. The examination of the gonads of the two species shows that they both breed in the summer months and it is not unlikely, therefore, that the intermediate forms in Dr. Chopra's collection represent hybrids between *Schizothorax labiatus* and *Oreinus sinuatus* var. *griffithii*.

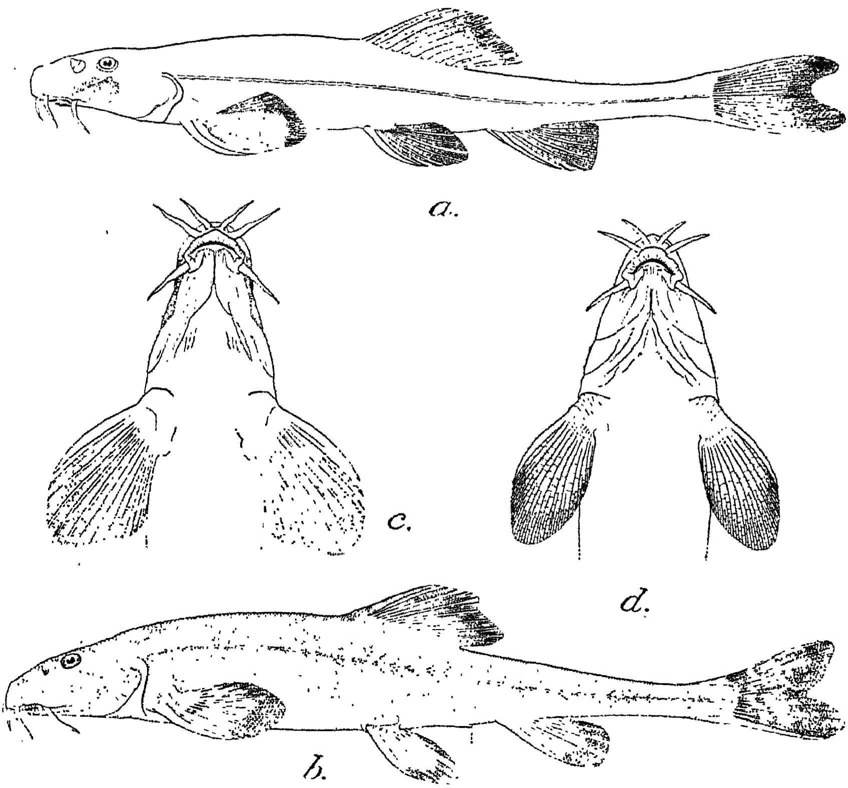
Nemachilus choprai, sp. nov.

D. 3/8 ; A. 2/5 ; P. 11-12 ; V. 8.

Nemachilus choprai is a large and stoutly built species in which the body tapers towards both ends, but very markedly towards the tail. The dorsal profile is gently arched, but the ventral surface is flat and horizontal and the ventral profile is almost straight up to the anal-opening. The caudal peduncle is long and narrow and whip-like. The body is naked, smooth and glossy. The paired fins are horizontally placed.

The head is depressed and flattened on the ventral surface ; it is evenly pointed in the female specimens whereas in the males the snout is broader and the extremity is much more rounded. The length of the head is contained 4·7—5·1 times in the total length without the caudal and 5·6—5·9 times in the length with the caudal. The width of the head is contained 1·4—1·6 times and its height at the occiput 1·6—1·9 times in its length. The depth of the body varies considerably with the sex of the individuals ; in some ripe females it is contained 5 times in the length without the caudal. Usually the depth is contained 5·9—9 times in the length with the caudal and 5—7·6 times in the length without the caudal. The eye is situated either entirely or for a greater part of its length in the posterior half of the head ; it is placed dorso-laterally and is not visible from the ventral surface. The diameter of the eye is contained 6·1—7·4 times in the length of the head, 2·9—3·5 times in the length of the snout and 1·5 to 2 times in the interobital distance. The nostrils are situated nearer to the eyes than to the tip of the snout ; there is a well marked flap between the

two nostrils on each side. There are six well-developed barbels, 4 rostral and two maxillary; all are much longer than the diameter of the eye. The small, lunate mouth is situated on the ventral surface considerably behind the tip of the snout; it is bordered by prominent fleshy lips which are continuous at the angles of the mouth. The lower lip is interrupted in the middle where the lower jaw is left uncovered. When the mouth is closed, the upper jaw, which is sharp and vertical, lies in front of the lower jaw. The lateral line is complete and well marked throughout its length. The caudal peduncle is long and narrow; its least height is contained 4·5—5·2 times in its length in the females and 5—5·9 times in the males.



TEXT-FIG. 9.—*Nemachilus choprai*, sp. nov.

a. Outline drawing of the lateral view of a male specimen showing secondary sexual characters. × ³⁄₅.
b. Lateral view of a female specimen. × ³⁄₅.
c. Ventral surface of head and anterior part of body of a male specimen. × 1.
d. Ventral surface of head and anterior part of body of a female specimen. × 1.

The difference in the general facies and in the form of the head in the two sexes is very marked.

The dorsal fin begins in advance of the ventrals and its commencement is almost midway between the tip of the snout and the base of the caudal; in some individuals it is somewhat nearer to the former than to

the latter. The longest ray of the dorsal is shorter than the depth of the body in ripe females; whereas it is invariably longer in the males. The upper margin of the fin is notched and its anterior upper corner is rounded. The pectoral fin is shorter than the head and is provided with a muscular base; it is rounded, horizontally placed and provided with a number of broad, bony rays anteriorly. The pectoral fin extends for about three-fifths of the distance between the bases of the pectoral and ventral fins. The ventral fin is situated on the ventral surface and is similar to the pectoral fin though considerably shorter; it just reaches or extends beyond the anal opening, which is followed by a deep groove. The males are provided with a well-marked papilla in this groove and in them the ventrals almost reach the base of the anal fin. There is a fleshy appendage at the base of the ventral which is adnate to the body throughout its length. The anal fin is short and its posterior margin is rounded; it is separated from the caudal fin by a considerable distance. The caudal fin is shorter than the head and is deeply emarginate with the lobes rounded. In some examples the upper lobe is slightly longer than the lower.

The colouration of this species seems to be fairly constant. The ground colour is pale-olivaceous with the ventral surface possessing a uniform lighter colour. The dorsal surface and the sides are clouded with a number of black patches which are more numerous and of a deeper colour above the lateral line. The ground colour appears in minute spots here and there. On the dorsal surface in the tail region there is a series of four to five broad, but short, bands of the ground colour. There are sometimes horizontal, narrow streaks of lighter colour in front of the dorsal fin. The pectoral, ventral and anal fins are without any markings. The caudal fin is irregularly marked with a number of bands, while there are indications of similar bands on the dorsal fin. The anterior margin of the undivided rays of the dorsal fin is conspicuously marked with about 5 dark spots. This last feature is characteristic of the species.

In young specimens, up to about 100 mm. in total length, the general colouration is relatively lighter and there is usually a series of rounded spots all along the lateral line.

Type-specimen :—F 11301/1, *Zoological Survey of India* (*Ind. Mus*).

Distribution and *Habitat* :—*Nemachilus choprai* is the only loach known from the Chitral Valley whence Dr. B. N. Chopra obtained as many as 131 specimens. They were collected in the following localities:—

(i) Forty-seven specimens from the Lutkuh River near Hot Springs (Sta. 9). (*Type-locality*).

(ii) Thirty-two specimens from the Mastuj River between Koghazi and Mastuj (Sta. 12).

(iii) Three specimens from a small stream above Charun in the Mastuj Valley (Sta. 14).

(iv) Forty-nine specimens from the Chitral River near the Chitral town.

Nemachilus choprai lives in large rivers with a swift current. The bed of such streams consists of stones and boulders with patches of sand and mud here and there. The water is usually clear but becomes muddy after freshets. Dr. Chopra did not observe any vegetation growing

in the large streams, but in the small stream above Charun there was plenty of vegetation and the bottom consisted of mud and sand with a few stones. The three relatively young specimens in the collection were obtained from this small stream, and it seems probable that the mature specimens migrate to smaller streams with plenty of vegetation for spawing purposes. In such situations the young not only get protection in vegetation, but they find a number of small organisms to feed on.

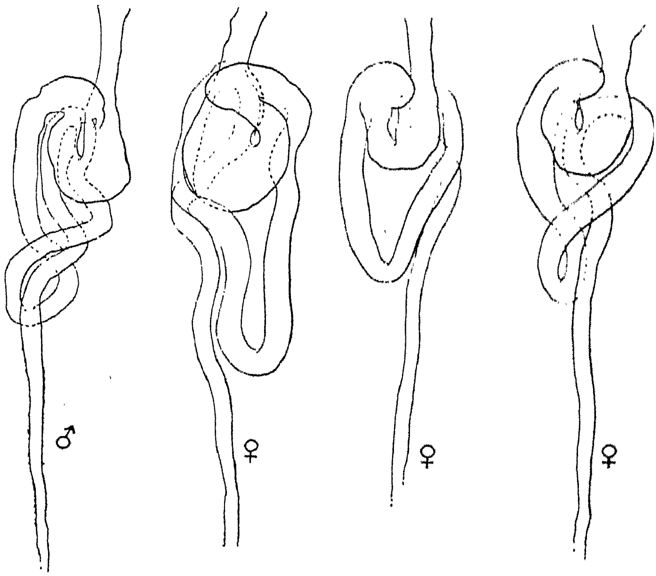
Sexual Dimorphism and *the Proportion of Sexes*:—*Nemachilus choprai* exhibits well-marked secondary sexual characters and the two sexes can be separated even in specimens about 100 mm. in total length though the species grows to about twice this size. The males are provided with the usual secondary sexual characters which consist of a raised tuberculate area below the nares, separated ventrally by a groove from the adjacent parts of the skin, of a second tuberculate area behind and below the first one and of broad pectoral rays which are provided with thickened tuberculate pads on their dorsal surface. Besides these obvious differences the males possess a broader and more rounded snout, a longer and narrower caudal peduncle and a papilla in the groove behind the anal opening. The males are usually of a larger size and in them the ventrals almost reach the anal fin.

Of the 131 specimens of *Nemachilus choprai*, there are 30 females and 101 males, or a proportion of 22·9 per cent. females and 77·1 per cent. males. If these calculations indicate an actual proportion of sexes in the population, the fact is remarkable. The preponderance of the males in the collection may be due to the fact that they are of much stronger build and are possibly of very active habits; whereas the females may be of secretive habits and thus liable to escape the notice of collectors. This alone, however, does not seem sufficient to account for the great difference in the percentage of the two sexes.

Bionomics.—*Nemachilus choprai* is a bottom dwelling fish. Its flattened ventral surface and broad, rounded and horizontal paired fins are no doubt used for grappling on to the smooth surfaces of rocks. The greatly reduced air-bladder also indicates that the fish lives mostly at the bottom, where it either crawls with the help of its paired fins, or darts from rock to rock with the help of its muscular tail and the whip-like caudal peduncle. Its long and narrow streamline form is adapted both for rapid movements as also for offering less resistance to swift-flowing currents. At the bottom the fish feeds on algae and slime that grow on rocks. Several kinds of Dipterous, Trichopterous and Ephemeropterous larvae that live on bare stones or among algae also form a substantial part of the food of this species. Large Coleopterous larvae that usually live among pebble at the bottom were also found in the stomach of *N. choprai*. The nature of food indicates a ground habit of life. The entire intestine is usually full of sand and gravel, most of which is probably derived from the cases of Trichopterous larvae and pupae.

The food is scraped from the rocks with the sharp and shovel-like posterior jaw while the anterior jaw, which lies in front of it and forms a vertical plate, helps to prevent the escape of the heterogenous scraped matter. The position, in which the coils of the alimentary canal lie,

varies considerably as shown in the accompanying figure. It appears that females feed most voraciously when the gonads begin to develop, but in specimens with fully developed ovaries the stomach is either empty or contains very little food. In such cases the liver is also greatly reduced. It seems probable, therefore, that about the spawning time the females give up feeding altogether. The ovaries fill up the body cavity to such an extent that feeding seems almost a physical impossibility. Most of the individuals opened had only insect larvae in their stomachs.



TEXT-FIG. 10.—Alimentary canal of *Nemachilus choprai*, sp. nov. × $1\frac{1}{3}$.
The four drawings illustrate the variable nature of the coils of the alimentary canal.

Remarks.—*Nemachilus choprai* belongs to the Central Asiatic group of species in which the caudal peduncle is long and narrow. It is closely allied to *N. tenuis* Day and *N. kashmirensis* Hora. The former possesses a narrower head and longer barbels; while in the latter the caudal peduncle is 3—3·9 times its least height and the eyes are situated almost in the middle of the length of the head. The colouration of *N. choprai* is different from either.

Until quite recently very little was known regarding the Nemachili that inhabit the waters of Afghanistan. Griffith[1] had observed that a loach was very common in the small channels by which the springs at Sir-i-Chashma run off and through the kindness of Major A. E. Farwell

[1] McClelland, *Calcutta Journ. Nat. Hist.* II. p. 564 (1842).

Measurements in millimetres.

	♀	♀	♀	♀	♀	♀	♀ (fig.)	♂	♂	♂ (fig.)	♂	♂
Total length including caudal	133·5	134·5	141·5	144·0	150·5	162·0	162·0	150·0	156·0	161·6	163·0	172·0
Length of caudal	20·0	21·0	21·0	21·0	22·0	22·0	25·5	25·0	22·0	23·8	25·0	27·7
Length of head	23·0	24·0	23·7	25·2	25·4	28·3	28·0	26·2	27·5	29·0	29·0	30·0
Width of head	15·7	16·3	16·5	16·7	16·3	20·0	19·2	17·2	17·4	19·0	20·0	18·0
Height of head	13·2	13·2	13·2	14·3	14·0	15·3	16·0	16·0	15·8	14·8	16·0	15·7
Depth of body	17·8	19·0	24·0	16·0	21·2	25·3	25·0	17·5	21·0	19·0	20·2	21·0
Length of snout	11·0	11·2	12·2	11·6	12·2	13·5	14·0	12·5	14·0	14·2	15·0	14·7
Diameter of eye	3·5	3·7	3·4	3·7	3·6	4·1	4·4	4·3	4·5	3·9	4·2	4·6
Interorbital width	5·6	5·8	6·0	6·5	7·0	7·5	8·0	7·0	7·2	7·8	6·3	8·0
Length of caudal peduncle	29·2	31·0	29·3	30·0	31·0	36·0	34·5	32·0	35·8	37·0	35·0	38·0
Least height of caudal peduncle	5·6	6·0	6·5	6·5	6·5	7·0	7·0	6·0	6·6	6·2	7·0	7·5
Longest ray of dorsal	18·7	17·5	18·2	18·6	20·1	21·8	21·0	18·5	21·0	20·6	22·0	26·0
Longest ray of anal	15·5	15·0	16·0	18·5	17·0	20·6	18·0	19·0	18·8	20·2	20·0	23·0
Length of pectoral	20·6	20·5	22·0	24·0	21·2	26·6	24·5	25·0	24·2	27·0	26·0	29·0
Length of ventral	18·0	17·0	19·6	20·0	19·5	21·0	21·5	20·5	20·7	22·0	21·0	24·2

four young specimens were obtained last year from this locality.[1] Similar specimens have also been collected from the Paghman River[2] and the Chahiltran stream, both tributaries of the Kabul River. This Kabul River form has been described by me as *Nemachilus griffithii* var. *afghana*. In this variety the caudal peduncle is not so long and whip-like as in *N. choprai*; the least height of the caudal peduncle being contained 2—2·2 times in its length. Besides these two forms, no other loach has so far been described from the upper reaches of the Kabul River and its tributary streams.

I (*op. cit.*, 1934) have recently remarked on the other species known from Afghanistan and it may be noted that *N. choprai* is abundantly distinct from all these forms. *Adiposia boutanensis* possesses an adipose dorsal and has a very characteristic facies, while *Nemachilus griffithii*, though very close to *N. choprai*, differs slightly in the length of the barbels, the position of the eye, the length of the pectoral, the colouration, etc., and has a different type of caudal peduncle. In the types of *N. griffithii* the least depth is contained 2·6—3 times in the length, whereas in *N. choprai* the figures are 4·5—5·9. When comparing the two forms, this character strikes one directly.

The measurements of a dozen specimens (7 ♀♀ and 5 ♂♂) collected in the Lutkuh River near Hot Springs are given on the opposite page.

Nemachilus kashmirensis Hora.

1876. *Nemacheilus rupicola*, Day (*nec* McClelland), *Proc. Zool. Soc. London*, p. 799.

1878. *Nemacheilus rupicola*, Day (*nec* McClelland), *Sci. Res. 2nd Yarkand Mission Ichthyology*, p. 17.

1922. *Nemachilus kashmirensis*, Hora, *Rec. Ind. Mus.* XXIV, p. 76.

In 1922, it was shown that Day had confused his Kashmir specimens of *Nemachilus* and had wrongly referred them to *N. rupicola* (McClelland), a species widely distributed in the Simla Hills. The name *kashmirensis* was proposed for this form and several specimens collected in the Verinag and Kukarnag Springs and in a small stream at Harwan were assigned to it. At the time I did not give a full description of the species and subsequently, owing to pressure of other work, it has not been possible to prepare a monograph on the Indian species of the genus in which I hoped to publish the description of the new species. *N. kashmirensis* is closely allied to the species described above and as Ka hmir and Chitral are adjacent countries I have thought it advisable to publish the account of the Kashmir form here.

D. 3/8; A. 2/5; P. 12; V. 8.

In *Nemachilus kashmirensis* the body tapers towards both ends and the dorsal profile is gracefully arched. The ventral surface is broad and flattened, and the ventral profile is straight and horizontal except in the region of the caudal peduncle. The fish is strongly built and

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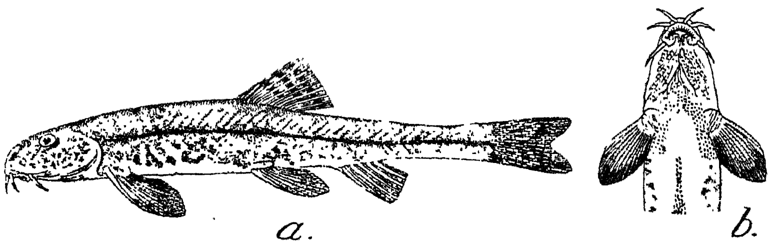
[1] Hora, *Journ. Bombay Nat. Hist. Soc.* XXXVII, (in press).

[2] Hora, *Journ. Bombay Nat. Soc.* XXXVI, pp. 697-699, pl. figs. 1 and 2 (1933).

possesses a whip-like, long and narrow caudal peduncle. The body is smooth and glossy and devoid of scales. The head is evenly pointed, but somewhat rounded towards the extremity.

The head is proportionately much longer in the young specimens; its length is contained 4—4·7 times in the total length without the caudal and 4·7—5·8 times in the length with the caudal. The width of the head is contained 1·3—1·5 times and its height at the occiput 1·6—1·8 times in its length. The depth of the body varies with age as well as with sex; it is contained 5·7—7·2 times in the total length without the caudal and 7—8·8 times in the length with the caudal. The eye is situated dorso-laterally in the middle of the head and is not visible from the ventral surface; its diameter is contained 5—6·5 times in the length of the head, 2—2·6 times in the length of the snout and 1·3—1·8 times in the interorbital width. The nostrils are situated nearer to the eye than to the tip of the snout. There are six barbels, two maxillary and four rostral; they are well marked and are longer than the diameter of the eye. The mouth is on the ventral surface behind the tip of the snout; it is bordered by well-developed lips, which are continuous at the angles of the mouth and are fimbriated. The lower lip is interrupted in the middle and each portion is reflected backwards. The ventral surface of the head is rugose and papillated. The lateral line is complete and well marked throughout its length. The caudal peduncle is long and narrow; its least height is contained 3—3·9 times in its length.



Text-fig. 11.—*Nemachilus kashmirensis* Hora.

a. Lateral view. × $\frac{3}{4}$.
b. Ventral surface of head and anterior part of body. × $\frac{3}{2}$.

The dorsal fin is situated in advance of the ventrals and its commencement is equidistant between the tip of the snout and the base of the caudal fin; its longest ray is greater than the depth of the body below it and its upper margin is oblique and truncate. The pectoral fin is somewhat shorter than the head and is rounded posteriorly; it is horizontally placed and possesses a strong muscular base; it extends almost two-thirds of the distance to the base of the ventral fins. The ventral fin is situated on the ventral surface and is similar to the pectoral fin; it extends considerably beyond the anal opening and is provided with a fleshy appendage at its base. The appendage is adnate to the body throughout its length. The anal fin is short and is similar to the dorsal; it is separated from the base of the caudal fin by a considerable distance. The caudal fin is somewhat shorter than the head; it is emarginate

with the lobes rounded, the lower lobe being slightly longer than the upper.

N. kashmirensis exhibits sexual dimorphism, but the secondary sexual characters of the male are not so well marked as is the case in several species of the Highlands of Central Asia. The rays of the pectoral fins are broad and bony in the males of *N. kashmirensis*, but tuberculated thickenings are absent on their upper surface. There is a slit-like groove in front of the eye, but there is no tuberculated pad on the head.

The colouration seems to vary considerably with growth. In adult specimens there are broad, black bands on the dorsal surface of the body. They are more marked in the tail region where they extend to the sides also ; but anteriorly they become lost in the general mottled colouration of the body. The body is of a dark colour just above and below the lateral line ; the upper surface of head is grayish while the entire ventral surface is pale-olivaceous. The dorsal fin is marked with three rows of spots across it, while the caudal fin is provided with about three wavy bands. The ventral and the anal fins are also spotted sometime, while the dorsal surface of the pectoral fins is infuscated with black markings. In the young individuals, besides the saddle-shaped bands on the dorsal surface, there are series of blotches along the lateral line or just below it on both sides. The general surface of the body is irrorated with black dots. In some specimens the body is covered with a number of anastomosing markings which superficially impart a uniform dark colouration to the upper surface and sides of the fish.

Type-specimen :—F10122/1, *Zoological Survey of India* (*Ind. Mus.*).

Distribution :—*N. kashmirensis* has been collected in Kashmir from the following localities :—

(i) Eight specimens from a stream flowing from the waterwork reservoir to the trout-farm at Harwan (*Type-locality*).
(ii) Seven specimens from a stream flowing out of the Kukarnag Spring.
(iii) Several young and half-grown specimens from the Verinag Spring.

Remarks.—It has already been indicated that *N. kashmirensis* shows great similarity to species with long and narrow caudal peduncle, such as *N. tenuis*, *N. lhasae*, *N. yasinensis*, etc. The following combination of characters distinguishes it from the allied species :—

(i) The ventral fin extends considerably beyond the anal opening.
(ii) The commencement of dorsal is equidistant between tip of snout and base of caudal.
(iii) The lateral line is complete and well marked.
(iv) The eye is in the middle of the head.
(v) The pectoral fin is somewhat shorter than the head.
(vi) The least height of the caudal peduncle is considerably greater than the diameter of the eye.

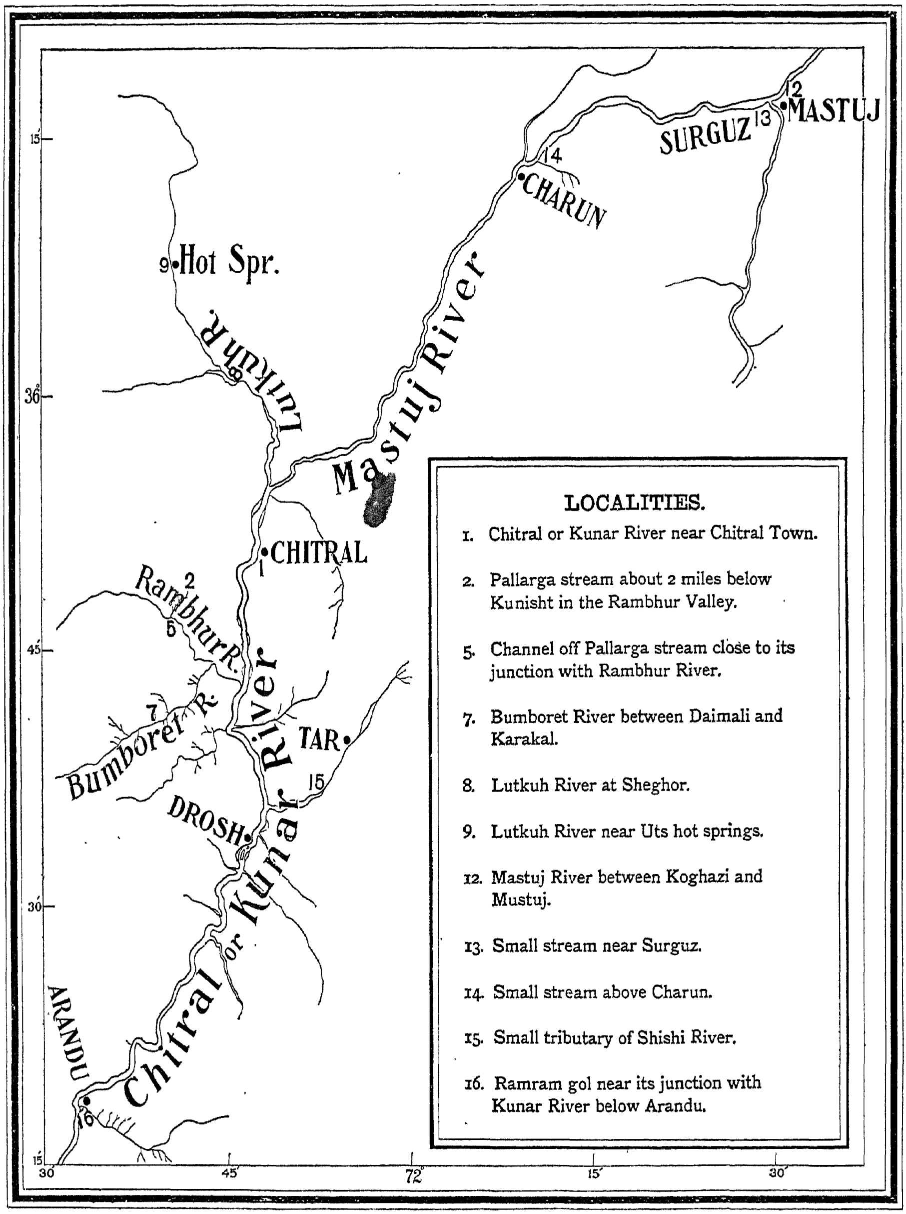
N. kashmirensis is further distinguished from all the related species by its general facies and the characteristic colouration.

Measurements in millimetres.

	Stream near trout-farm at Harwan.			Stream flowing out of Kukar-nag Spring.		Verinag Spring.	
Total length including caudal	98·5	92·4	77·4	93·8	62·4	55·0	41·2
Length of caudal	16·5	16·2	12·4	15·0	11·4	10·0	7·2
Length of head	17·6	16·0	13·7	17·0	12·2	11·0	8·6
Width of head	12·0	11·8	9·5	12·0	8·2	7·2	5·7
Height of head at occiput	10·0	9·8	7 3	10·6	7·1	6·2	4·8
Depth of body	12·2	13·3	9·0	12·3	8·3	6·2	4·8
Length of snout	7·9	7·7	5·3	7·8	5·6	4·9	3·4
Diameter of eye	3·2	3·0	2·1	3·1	2·4	2·0	1·7
Interorbital distance	4·9	5·0	3·9	4·8	3·2	2·8	2·6
Length of caudal peduncle	18·3	16·5	16·6	16·5	11·0	10·2	7·8
Least height of caudal peduncle	5·6	5·5	4·4	5·0	3·3	2·8	2·0
Longest ray of dorsal	12·8	13·0	11·0	13·0	9·5	9·5	6·2
Longest ray of anal	12·0	10·8	8·5	11·5	7·5	7·0	4·3
Length of pectoral	16·5	14·0	13·5	15·6	12·0	10·7	6·4
Length of ventral	13·2	12·4	10·8	13·5	9·0	8·5	4·6

EXPLANATION OF PLATE III.

A sketch map of the river system of the Chitral Valley, showing the principal localities in which fish were collected.



LOCALITIES.

1. Chitral or Kunar River near Chitral Town.
2. Pallarga stream about 2 miles below Kunisht in the Rambhur Valley.
5. Channel off Pallarga stream close to its junction with Rambhur River.
7. Bumboret River between Daimali and Karakal.
8. Lutkuh River at Sheghor.
9. Lutkuh River near Uts hot springs.
12. Mastuj River between Koghazi and Mustuj.
13. Small stream near Surguz.
14. Small stream above Charun.
15. Small tributary of Shishi River.
16. Ramram gol near its junction with Kunar River below Arandu.

Sketch Map of the River System of Chitral Valley.

EXPLANATION OF PLATE IV.

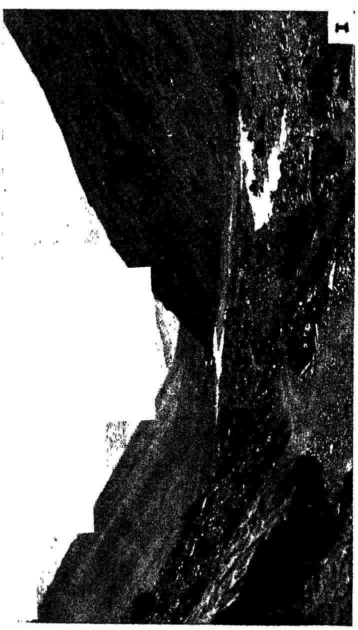
PHYSICAL FEATURES OF THE CHITRAL VALLEY.

FIG. 1.—The narrow and deep valley of the Lutkuh River.

FIG. 2.—Junction of the Lutkuh and the Mastuj Rivers to form the Chitral River. Notice the steep and bare hills.

FIG. 3.—A Red Kaffir basket used as a trap below a small waterfall to catch fish.

FIG. 4.—A small stream couple of miles above Rambhur, showing growth of vegetation on its sides.



B. Chopra, Photo.

Physical Features of the Chitral Valley.

From the Journal and Proceedings, Asiatic Society of Bengal (New Series), Vol. XXX. 1934, No. 1.

Issued 22nd November, 1934.

Trade in Live Fish (*Jiol Machh*) in Calcutta

By Sunder Lal Hora

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ARTICLE No. 1.

Trade in Live Fish (*Jiol Machh*) in Calcutta.

By SUNDER LAL HORA.

(*Public Lecture delivered at the Asiatic Society of Bengal on Friday, the 31st of August, 1934, and published with permission of the Director, Zoological Survey of India.*)

In his account of the Fish and Fisheries of Bengal, Francis Buchanan (afterwards Hamilton) records the following observations under the general account of the fisheries of the Purnea District. 'In the cold season some boats, of from 100 to 200 maunds burthen, are half filled with water, and great quantities of small fish are put into them, and sent living to Calcutta. The fish are so thick that they are just kept wet, but the water is frequently renewed. The kinds are the Singi, Mauri, and Kabai, all small fishes very tenacious of life, and in much request with the natives, as supposed to possess restorative powers'. In several volumes of Hunter's Statistical Account of Bengal, there are references to the trade in live fish, and I quote here two which seem to be of special significance. In the account of the Jessore Fisheries it is stated that 'The fish is kept fresh by the ingenious and simple device of perforating the bottom of the boat, and confining the water which enters by means of two boards stretched from gunwale to gunwale. A tank or reservoir with a constant supply of fresh water is thus formed, and the fish reach their destination alive. The finer varieties, however, such as the rui and katla, etc., cannot support this treatment, and would die. They are, therefore, not exported in quantities from Jessore; and indeed Nadiya, with its railway communications, has obtained this branch of the trade. But the coarser species, such as kai, magur, etc., bear the confinement easily, and are retailed alive from villages on river banks in the neighbourhood of Calcutta, Hughli, etc., under the name of Jessore fish . . . . . The kai, a small black-green purse-mouthed fish, is greatly esteemed by Bengalis as a restorative after sickness'. Mention is also made of the fact that 'From the fishing grounds of Bakarganj, boats laden with fish are continually passing through the Jessore Sundarbans to Calcutta. The vessels are filled with water and fish in perhaps equal bulk, and the water is continually cast out and new water cast in. The fish die in great numbers, and are thrown out as they die, but sufficient reach Calcutta alive to pay for the trip'. In the account of the Faridpur District, a reference is made to *Jiol Machh*, and it is stated that 'The fishes in this case are stored in reservoirs constructed in the middle of the

boats and closed by a grating at bottom, through which a constant and fresh supply of water is afforded. The boats are well manned and swift, and are pulled day and night'. De, in his 'Report of the Fisheries of Eastern Bengal and Assam', devotes to the mode of transport and value of live fish a paragraph which is very instructive in this connection. He says: 'Certain fish fetch a high price if sold alive, and are of much less value when dead. They are supposed to be very nourishing if killed just before cooking. These are called *jiol* (alive) fish and are the *Magur*, the *Singi* and the *Koi*. Some other species of fish which are transported similarly also come under the same designation, and are the *Shol*, the *Lati* or *Cheng*, and the *Gajar*. They all possess specially-contrived breathing apparatus enabling them to live for a long time in very little water, and some of them are known to walk across land from one water to another. Such fish are easily transported alive to long distances. When large numbers are to be carried, they are placed in water in the hold of a boat. A circulation of fresh water is maintained by a small hole being bored in the bottom of the boat, through which water wells up, while one or more men are engaged in constantly bailing the excess water out. The hole is stopped with a peg when the bailers rest. These fish are caught in *bhils* and other confined waters and carried in this way to very great distances such as from Faridpur and Bakarganj to Calcutta. For shorter journeys they are carried in earthen pots or canisters containing water, which is changed once or twice a day. They are kept alive in this way in the consumers' houses for several days.'

The above remarks indicate that in the 'live fish' trade a special technique has developed and that in the ingenious devices to be referred to presently advantage is taken of the mode of life of the species collectively known as *Jiol Machh*. I will now refer briefly to the bionomics of these fish to indicate how they differ in certain essential respects from our ordinary conception of fishes.

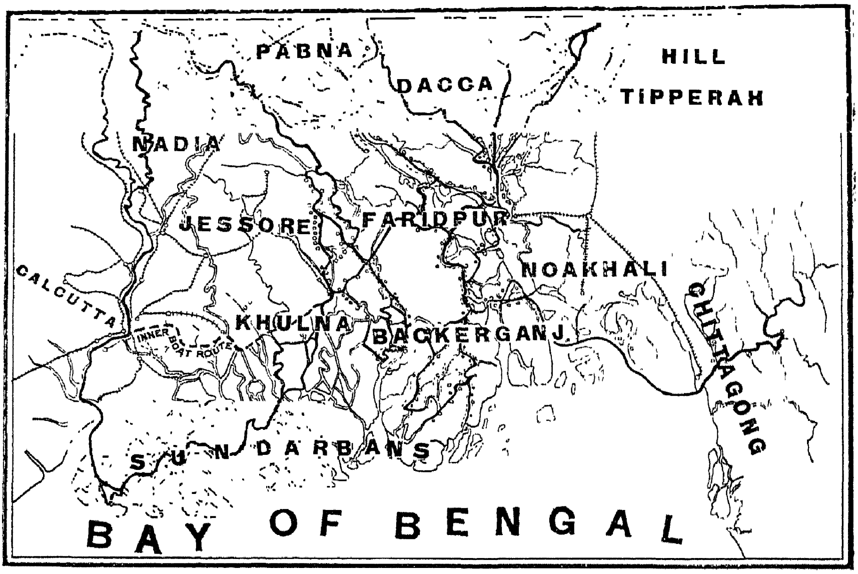
In India and further east, there are many varieties of fish which are capable of living out of water for considerable periods, and even of making periodic excursions on land. These are very hardy species and are able to survive conditions fatal to most other kinds of fish. In their natural haunts, such as foul-smelling marshy areas, when the water has been drawn off or has evaporated, as often happens during drought, they are capable of living in pools of liquid mud and when these dry up they burrow in the mud for a foot or two and survive so long as the earth is moist beneath. This highly unfish-like behaviour is due to the fact that in them air-breathing organs or 'lungs' have been developed and it has become possible for them to oxygenate their blood directly with the atmospheric air. On lifting the gill-cover of a *Koi* (*Anabas*) or *Khalisha* (*Trichogaster*), one sees a chamber situated above the gills and

formed as an outgrowth of the ordinary gill-chamber. Each of these accessory chambers contains a labyrinthiform organ, composed of shelf-like plates with wavy edges and supplied with fine blood vessels. When the air is inhaled through the mouth it enters this chamber and the labyrinthiform organ acts as the 'lung' of the fish.

In *Sauli* and *Lata* (*Ophicephalus* spp.) the accessory respiratory organs are in the nature of two lung-like reservoirs in the head, developed as pouches of the pharynx. The inner linings of these cavities are richly supplied with blood. The respiratory chambers of *Cuchia* (*Amphipnous*) are of a similar nature. In this fish the gills are greatly reduced and it seems to have lost practically all its power of aquatic respiration. In *Magur* (*Clarias*) there is an air-chamber situated above the gills into which tree-like outgrowths project from the upper ends of the gill arches. In *Singi* (*Saccobranchus*) a long tubular sac grows backwards from the opercular or the gill cavity and extends as far as the middle of the tail. This sac bears a marked resemblance to the lungs of land vertebrates. These are the principal fish which constitute the trade in live fish. It is not my intention to deal with all the aspects of this business, but to confine my attention to the sale of this commodity in Calcutta with such incidental remarks on other aspects of the fishery as may be called for in the treatment of the subject.

I am informed that in Calcutta there are three principal wholesale markets for the disposal of *Jiol Machh*, one at Chingrighata, not very far from the Dhapa Lock, one at Kidderpore on Tolly's Nullah, and the third at Ultadanga, opposite the Deshbandhu Park on the Canal West Road. There are places on the Hooghly River which are also known for the sale of 'live fish', but they are not of much significance from the commercial point of view. Not very long ago, there used to be a big market at Salkia on the western bank of the Hooghly, but on account of its relative inaccessibility it has been given up. The entire quantity of fish sold in the three markets enumerated above is brought to Calcutta from the deltaic districts of Lower Bengal, such as Faridpur, Bakergunj (Khulna), Jessore, the 24-Parganas, Barisal, Madaripur. and Dacca. The majority, if not all, of the boats laden with 'live fish' pass through the Krishtopur Canal before reaching Calcutta and it is a common sight to see boats, mostly small but a few large ones also, being towed to Calcutta in a characteristic way (Plate I, fig. 1). To a central post in the boat a number of ropes are tied and these are passed on to people on the shore. These persons pull the boat along with the help of these ropes and only one man is then needed on the boat for steering purposes. Most of the boats come to Ultadanga, which, I am given to understand, is the most important market now for the sale of *Jiol Machh*. Chingrighata used to be the foremost

market for this purpose, but it has lost its popularity in favour of the Ultadanga market. Here during the winter months twenty to thirty small boats may be seen lying along the western bank of the canal (Plate 1, fig. 2), but unless one goes there very early in the morning, the way in which the fish trade is carried on cannot be appreciated. Between the hours of 6 and 8 in the morning, there is great activity and it is practically impossible to find anyone to help with the collection of information one may be interested in. By 8 o'clock the regular business is finished and the fishermen busy themselves with the preparation of their midday meal (Plate 1, fig. 3). These



TEXT-FIG. 1.—Sketch Map of Lower Bengal showing the position of the deltaic districts from where *Jiol Machh* (Live Fish) are imported into Calcutta.

Full thick line indicates the route that can be used all the year.

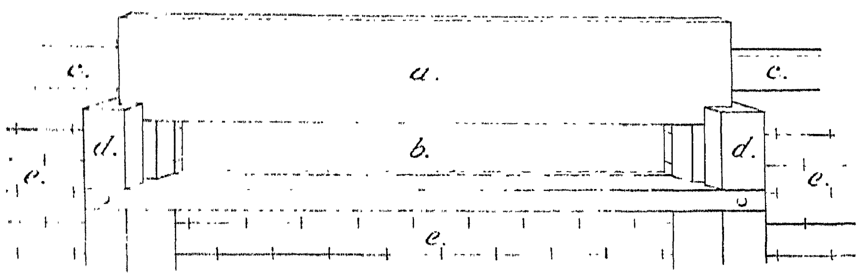
Broken thick line indicates the inner boat route which shortens the journey by many days and is used by a majority of *Jiol Machh* boats.

hours for the sale of the fish are natural, for the fish are taken from here to the various markets of the town for retail purposes. At the same time it is considered highly undesirable to disturb the fish more than once in the course of 24 hours, and it is difficult, therefore, to persuade these people to sell the fish after the early morning hours.

The fish occupy the entire hold of the boat with a sufficient quantity of water to cover them. As a rule ⅞th of the depth of the boat is filled with fish and water and there are stout wooden cross-bars in the boat, known as 'Gurroh', to indicate this level. The hold is covered by narrow planking in sections

in such a way that a part or the whole of it can be exposed when needed (Plate 1, fig. 4). By this arrangement the fish lie in a cool and semi-dark place, and the planking provides a flooring space for the people to move about, cook their food, etc.

Though the *Jiol* fish are air-breathing fishes, a certain quantity of good water is still essential for their healthy existence. Before the commencement of the journey, the required quantity of water is taken from the natural haunts of the fishes through a perforation at the bottom of the boat. In some boats there is no perforation at the bottom, but a portion of the edge is built in such a way that a small piece of wood can slide in and out. When it is desired to add water, the piece is taken out and the boat is tilted towards the side and water enters through the temporary opening. After taking in the desired quantity



TEXT-FIG. 2. Sketch of an arrangement by which water is filled in some of the boats engaged in the trade of *Jiol Machh* (Live Fish).

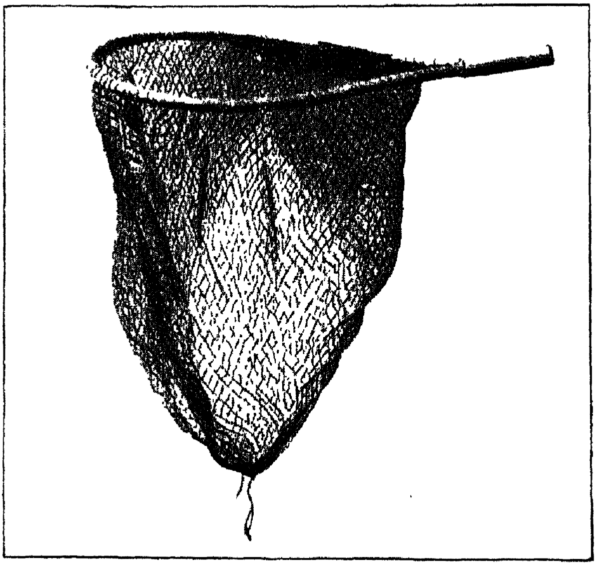
a=Sliding plank or door; *b*=Opening after the door is lifted upwards; *c*=Edge of the boat; *d*=Grooved pillars in which the door slides; *e*=A portion of the boat's inner surface.

By tilting the boat on the side of this arrangement and by lifting the door upwards, water is allowed to go into the boat. In some cases, this device is fitted in the wall of the boat itself.

of water the hole is plugged securely, and usually no change of water is made *en route*, the main reason being that the canal water, through which the boats travel, is too saline and, therefore, unwholesome for the fish. If, however, the water in the boat becomes very foul in the course of the journey, it is bailed out and replaced by fresh water from some pond or tank near the banks of the canal. During the period of stay at Calcutta, the water in the boat is changed once every day between 9 to 10 in the morning after the business for the day is over. The old water is at first bailed out with the help of a *Dhāmā* (Plate 6, fig. 3), usually from the front end of the boat and a fresh supply is taken at the hinder end. When the bailing out of water is going on, the fish are frightened by the noise and lie quietly at the bottom so that the water can be bailed out without any fear of throwing away the fish. Canal water is not used for

this purpose, but unfiltered Hooghly water supplied by the Calcutta Corporation is taken through a hose-pipe and allowed to fall into the boat from some height (Plate 6, fig. 6). By this arrangement, thoroughly oxygenated and wholesome water is supplied to the fish. The Calcutta Corporation charges a monthly fee (about Rupees thirty) for the supply of water, and this sum is raised from among the owners of the boats.

The sale of the fish is effected through the intermediation of a broker who measures out the quantities of fish (Plate 2, figs. 1 and 2). No weights are used but baskets of different sizes and shapes are employed as measures (Plate 4, figs. 1 and 2). On the 13th of January, 1933, I noticed a boatman



TEXT-FIG. 3.—Net used for taking out smaller fish from the hold of a *Jiol Machh* boat.

selling fish to a person who intended to take them to Jamshedpur (Tatanagar) by rail at the rate of Rs. 1-12 per 10 small baskets (*Chhoto Jhāṇkā*), each of which contained approximately $1\frac{1}{2}$ *paws* of fish. After purchase, the man kept the fish in canisters with a small quantity of water and he informed me that in the course of the journey he will have to change the water at least four times. There must be a great demand for this type of fish, for up to Jamshedpur the person had to pay Rs. 1-12 per maund for fish and water in the canisters besides other incidental expenses. I was told that at the Ultadanga Ghat, the price of this kind of fish usually varies between Rs. 40 to Rs. 60 per maund according to the season and the state of the market.

For sale in the local markets, the fish is carried in big baskets known as *Gāchhā* which are strengthened in various ways for durability (Plate 5, figs. 1–3). *Jiol Machh* can leap up to considerable heights, and, therefore, the baskets have to be kept covered but sometimes netting is used on the top in an ingenious way (Plate 5, fig. 3). Usually flat, shallow baskets are used as covers (Plate 6, figs. 1 and 2). When taken to a market, the fish are transferred to a large earthen *gamla* in which they are kept in a small quantity of water. A plank of wood behind the *gamla* serves as the seat for the seller who exhibits a few of the fish on a banana leaf in a shallow basket (Plate 2, fig. 3). Usually there is a small quantity of water on the banana leaves and the fish wriggle about in it and keep their surface and respiratory organs moist. In the local markets the retail price is fixed per piece or the fish are sold by weight. A visit to the Shambazar Market about midday showed that the section for the sale of 'live fish' was almost deserted. I was informed, however, that during the early hours brisk business goes on in this section. Bengali women carry on this business in the market.

Some people, mostly Beharis, sell 'live fish' in the streets, and even here there are two categories. Certain people establish way-side temporary shops by keeping a few baskets full of different types of *Jiol Machh* in front of them at a street corner or some other suitable place (Plate 2, fig. 4). They sell the fish by weight, and to a buyer of a large quantity they give the fish in a small basket for which they charge only a nominal price. The second category consists of street-hawkers (Plate 3, fig. 1) who move from place to place with baskets full of fish on their heads. The basket is lined on the inside with banana-leaves (Plate 3, fig. 2) and a small quantity of water is sprinkled over the fish to keep them moist. The banana-leaves help to retain this water in the basket which is beneficial for the fish and at the same time prevent the water from dripping on the hawker. The *Gāchhā* is covered with a shallow basket to prevent the fish from jumping over. The fish is usually sold by weight and the pans of the balance consist of two small, deep baskets (Plate 3, fig. 2). When the fish are sold, a common string is passed through their gill-openings or each fish is secured by a separate piece of string and the fish dangle about as they are being carried home for consumption (Plate 3, fig. 3). Some more merciful people carry them in small baskets. The treatment they receive in the homes must be familiar to most of us. The fishes like *Singhi* and *Magur*, which are greatly dreaded on account of their spines, are first treated with a pinch of salt on their heads. This has the immediate effect of narcotizing them so that they can be handled without fear. *Bonti*, a kind of a bent knife fixed in a wooden board (Plate 6, fig. 5), is used to cut off the heads and for cutting them up into pieces

(Plate 3, fig. 4). The pieces are then put in a basket (Plate 6, fig. 4) and thoroughly washed before transferring them to the cooking pot.

A much more cruel method is sometimes used for killing these fishes. A fish is caught by the tail and its head is hit against some hard substance or its head is hit with something hard. The fish has to be knocked several times before it is killed.

Jiol Machh are greatly in demand among the Bengali population of Calcutta for their flavour, taste, and nutritional value. They are believed to be very good for invalids as they are considered to be light, nutritious, strengthening, and restorative. On account of all these special qualifications, one can imagine that great care is taken to keep these fishes in a fit condition for consumption as a suitable article of diet. But unfortunately this is not so. Most of the Bengalis in Calcutta are, no doubt, familiar with the allusion in the popular saying 'Jessore Koi', but for the benefit of others I shall explain it here. *Koi* fish at Jessore is fat, plump, and rich, but by the time it arrives in Calcutta in boats, it becomes very thin and emaciated, so much so that the head-portion becomes very prominent and body-portion lean. After a prolonged illness, a person's head seems proportionately larger and the body and limbs very thin. So the phrase 'Jessore Koi' is used for a person who recovers from prolonged illness and is consequently very thin and emaciated. *Jiol Machh* during transportation lose a great deal of their weight as they are not fed from the day they are captured to the day they are eaten, and this period may range from two to four weeks according to the distance and tendency of the market. No one seems to have realized what a wastage of valuable food-material occurs during this period of forced starvation of the fish. If some cheap food could be prepared and the utility of it demonstrated to the fisher-people, I am sure, much good could result to this trade in the increase of the market value of these fish on account of their enhanced nutritional value.

Considerable work has been done on the effect of starvation in other animals, but in the case of fish there seems to have been difficulty in collecting the excreta for metabolic studies and the inability to give a definite amount of food and water seems to have been another obstacle. On the analogy of what has been found in other animals, it can be safely presumed that even in fishes the first line of defence against starvation is the depletion of the glycogen stored in the liver and other tissues. After the consumption of the carbohydrates, the fats and proteins would be next consumed, leading to the breaking up of the body-tissues, depending on the degree of starvation. It follows, therefore, that the protein and fat value of a fish which has been starved for a fortnight or so would be much inferior to

that of fresh fish of the same species. The preparation of a suitable food for these fish during their period of confinement and starvation is a simple matter, but no attention has unfortunately been paid to this important question. They are being exploited without the slightest idea of conservation. Fortunately, Nature is bountiful in showering its blessings on this land, but man is interfering with Nature to such an extent that fisheries may fail altogether. It is, however, hoped that before long necessary steps will be taken to preserve the fisheries of this country.

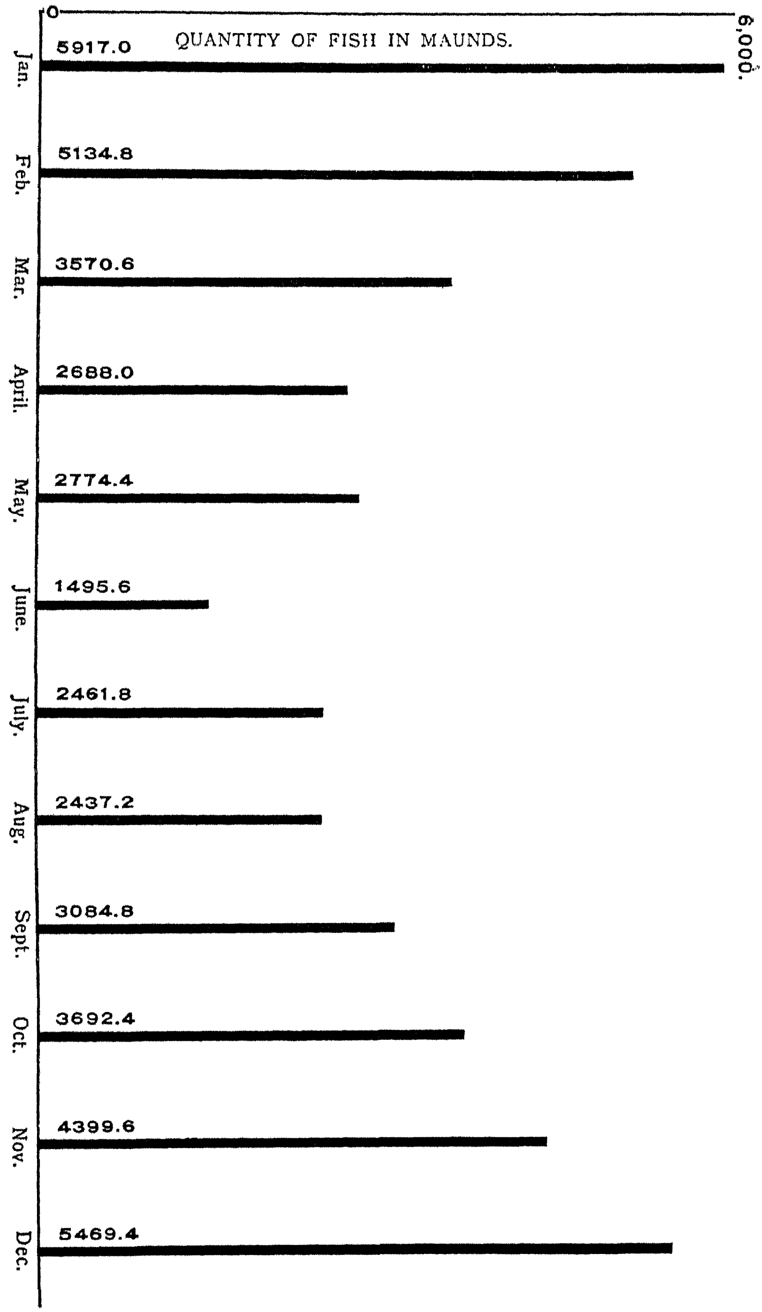
As any talk about fisheries is incomplete without statistics, I propose now to place before you a statement of fish-boats entering Calcutta through the Krishtopur Toll Station, showing approximately the quantity in maunds of fish and number of boats month by month for the five years, 1928 to 1932 (Table I). I have already remarked that most of the fish-boats carrying 'live fish' to Calcutta have to pass through the Krishtopur Toll Station, and, as the statement shows, on an average 43,146·4 maunds of fish are imported into Calcutta every year. This is not a small quantity and any effort made to improve the quality of this fish seems certainly worth while. During the dry months, from October to June, the transportation of fish is carried on by small boats and consequently the number of boats employed is large, about 300 boats per month, while the average quantity of fish carried by these boats is about 14·5 maunds per trip (Table II). During the monsoon months only a few boats are used for this trade, but they are of about 36 maunds capacity, so that with the reduction in the number of boats, the supply does not fall proportionately. It is further seen that the supply of this kind of fish is most abundant from October to March, the peak period being January, and it falls off gradually till in June the quantity imported in Calcutta is about 1,500 maunds only. The rise and fall in the quantity of fish month by month is governed by biological laws and can be readily explained with the help of our knowledge of the bionomics of these fishes. With October or November, the dry-season starts in India and the water in the rivers, tanks, pools, and ditches begins to fall due to gradual evaporation. As the vast expanses of water dry up, the fish come together to live in pools and puddles and fall a ready prey to the ingenious devices used by man in capturing them. I do not propose to deal with these devices here, as it is a long subject and must be treated separately and cannot be adequately dealt with within a few minutes. In April, May, and June, the marshes and ponds dry up altogether and the fishes bury themselves at considerable depths in the ground to tide over this unfavourable period. In consequence the supply of *Jiol Machh* falls considerably. With the monsoon, the country is flooded and the sleeping or æstivating fishes are revivified. The fish become abundant, but, on

account of the floods and high waters, they are not accessible. The supply improves during the rains, but the real fishery season for these fish starts with the fall of water in October or November.

During the rainy season—July, August and September—the majority of *Jiol* fish brought to Calcutta belong to the labyrinthine fishes of the genera *Anabas* (*Koi*) and *Trichogaster* (*Khalisha*), while after the rains from October to February *Ophicephalus* (*Sauli*, *Lata*, *Murral*) and *Anabas* are most abundant; *Trichogaster* decreases in quantity. During the hot months, April, May and June, 90% of *Jiol Machh* consist of *Saccobranchus* (*Singi*) and *Clarias* (*Magur*). From the middle of February to the middle of April some people do not eat *Singi* and *Koi*, for they are believed to spread smallpox. During these months, the skin of these fishes is covered with small, raised, round patches which correspond in appearance to the marks of smallpox. It is probable that this is the breeding season of these fishes and that this period is enjoined as the close season.

A few words about the people who bring the supply of *Jiol* fish to Calcutta will not be out of place here. It has been stated that it takes 8 to 10 days for the journey from Faridpur to Calcutta, 4 to 5 days from Khulna, and a somewhat shorter period from Jessore and 24-Parganas. A stay of 5 to 10 days is made in Calcutta to dispose of the cargo and the return journey takes about a week or so. Soon after the arrival of the boat in the fishing ground, the owner of the boat loads it with a fresh supply and the Calcutta journey starts once again. It was ascertained that on an average one trip a month is made by these boats. The minimum number of men on each boat is three, one *manjhi* (boatman) and two *dharis* (paddlers), but this number depends upon the size of the boat. Formerly these people obtained a certain percentage of profit, but on account of trade depression, they now receive a wage of 6 to 10 rupees a month, according to their qualifications, besides food-rations. The purchase price of the fish is not known to these people, for it is the concern of the owner of the boat. Each boat costs about Rs. 150 to Rs. 500 according to its size, and the carrying capacity of a small boat is estimated to be 6 to 7 maunds of fish besides a quantity of water. About 90% of the people employed in this trade are Mahommedans by religion.

I have not dealt with the methods of capture of *Jiol Machh* nor with the popular beliefs and superstitions that have grown up round this class of fish. A *Jiol Machh*, when alive, fetches 3 to 4 times as much price as a dead one of the same kind and, therefore, a dead *Singi* or *Koi* is eaten only by the poorer people. These fishes have the merit of being absolutely fresh when cooked, and it is no wonder that they are prized so much.



Graph showing average quantities of fish in maunds brought to Calcutta during the different months of the year from 1928 to 1932.

TABLE I.

Statement of fish-boats entering Calcutta area through Krishtopur Toll Station showing approximately the quantity in maunds of fish and number of boats, month by month, for the years 1928, 1929, 1930, 1931, *and* 1932.

Month.	1928.		1929.		1930.		1931.		1932.	
	Boats.	Quantity.	Boats.	Quantity.	Boats.	Quantity.	Boats.	Quantity.	Boats.	Quantity.
January ..	489	5,838	607	6,150	503	6,760	563	4,333	389	6,508
February ..	369	8,224	380	3,920	400	3,971	390	4,529	473	5,030
March ..	298	4,783	307	3,285	241	2,485	324	3,018	397	4,282
April ..	252	3,648	174	2,708	166	1,755	233	2,275	263	3,054
May ..	184	2,763	115	1,394	121	6,291	173	1,884	130	1,540
June ..	106	2,379	75	817	55	1,110	76	1,770	84	1,402
July ..	69	4,258	50	997	50	2,122	78	2,823	77	2,109
August ..	78	3,581	66	1,223	86	2,890	43	1,050	108	3,542
September ..	82	2,626	72	4,730	71	2,353	58	2,225	83	3,490
October ..	235	3,220	190	5,624	269	4,047	192	1,858	211	3,713
November ..	365	5,207	357	5,487	342	3,592	335	5,302	348	2,410
December ..	532	6,937	334	4,991	475	4,629	459	4,565	576	6,225
TOTAL ..	3,059	53,464	2,727	41,326	2,779	42,005	2,924	35,632	3,139	43,305

TABLE II.

Statement of average quantity of fish per boat in maunds brought to Calcutta during the different months of the year, from 1928 to 1932.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct	Nov.	Dec.
1928 ..	11·93	22·28	16·05	14·47	15·01	22·44	61·71	45·91	32·04	13·70	14·26	13·03
1929 ..	10·14	10·31	10·70	15·56	12·12	10·89	19·94	18·53	65·69	29·60	15·37	14·94
1930 ..	13·44	9·92	10·31	10·57	52·00	20·19	42·44	33·60	33·14	15·04	15·03	9·74
1931 ..	7·69	11·61	9·31	9·76	10·88	23·28	36·19	24·41	38·36	9·67	15·82	9·94
1932 ..	16·73	10·63	10·78	11·61	11·84	16·69	27·38	32·79	42·04	17·59	6·92	10·80
Average quantity per month per boat ..	11·98	12·95	11·43	12·39	20·37	18·69	37·53	31·05	42·25	17·12	13·48	11·69

EXPLANATION OF PLATES.

TRADE IN LIVE FISH (*JIOL MACHH*) IN CALCUTTA.

PLATE 1.

Fig. 1.—A view of the Krishtopur Canal, North Calcutta. Notice the boats being towed by men on the bank by means of ropes tied to poles in the middle of boats (p. 3).

Fig. 2.—Wholesale market for *Jiol Machh* at the Ultadanga Ghat. Several boats are seen lying opposite the Deshbandhu Park along the western bank of the Canal West Road (p. 4).

Fig. 3.—Closer view of a few small boats at the Ultadanga Ghat containing *Jiol Machh*. Most of the men are attending to the preparation of their midday meals after the morning hours of business (p. 4).

Fig. 4.—Two boats containing *Jiol Machh*. The narrow planking in sections used to cover the hold, where the fish are stored, is clearly seen (p. 5). The hold is partly uncovered in the boat on the right.

PLATE 2.

Figs. 1 and 2.—Sale of *Jiol Machh*. The owner is supplying fish from *Dūrē* to the broker who goes on measuring the quantity with the help of *Chhoto Jhāṇkā*. The purchaser is putting fish in canisters for railway transportation. Many people gather round to watch the transaction (p. 6).

Fig. 3.—*Jiol Machh* Section of the Shambazar Market, Calcutta, at about midday. Very few people were in the market at this hour (p. 7).

Fig. 4.—A way-side temporary stall of a Behari for the sale of *Jiol Machh* (p. 7).

PLATE 3.

Fig. 1.—A Behari street-hawker of *Jiol Machh* (p. 7).

Fig. 2.—A Behari street-hawker of *Jiol Machh* weighing fish for a customer. The inner banana-leaf lining of the basket and the cover lying beside it may be noticed (p. 7).

Fig. 3.—*Jiol Machh* being carried home by means of strings passed through the gill-openings (p. 7).

Fig. 4.—A house-maid cutting up *Jiol Machh* and preparing them for the cooking pot (p. 8).

PLATE 4.

Fig. 1.—Two small fish measures, *Chhoto Jhāṇkā* and *Baṛo Jhāṇkā*.

Fig. 2.—Large fish measure, *Dūrē*.

Fig. 3.—A wide-meshed circular net (*Jâl*) with an iron rim used for taking out larger fish, such as *Sol* (*Ophicephalus striatus*), from the hold of a boat. Wide mesh allows smaller fish to pass through.

PLATE 5.

Large baskets (*Gāchhā*) for carrying *Jiol Machh*. Basket in figure 2 is strengthened by means of strings of twine. Basket in figure 3 has a netting on the top to prevent fish from jumping out. Basket in figure 4 has a narrow mouth which prevents the fish from jumping out.

PLATE 6.

Figs. 1 and 2.—Shallow, plate-like baskets used as covers for big baskets (*Gāchhā*) and for laying out *Jiol Machh* for sale.

Fig. 3.—*Dhāmā*, a basket with a handle used for bailing out water from a boat and for taking out fish from the hold.

Fig. 4.—*Khāloi*, a small basket used for miscellaneous purposes, such as carrying fish from market, for washing cut pieces of fish, etc.

Fig. 5.—*Bonti*, a big knife fixed in a wooden board for cutting up big fish into large pieces.
Katāri, a bent knife for cutting bigger pieces into smaller pieces.

Fig. 6.—Fresh water being added to a boat from a hose. As the water falls from a considerable height, it becomes thoroughly oxygenated (p. 6).

Issued November 22nd, 1934.

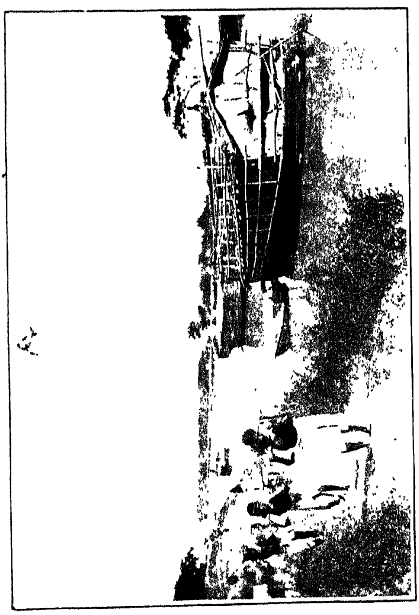


FIG. 1.—Boats in the Krishtopur Canal.

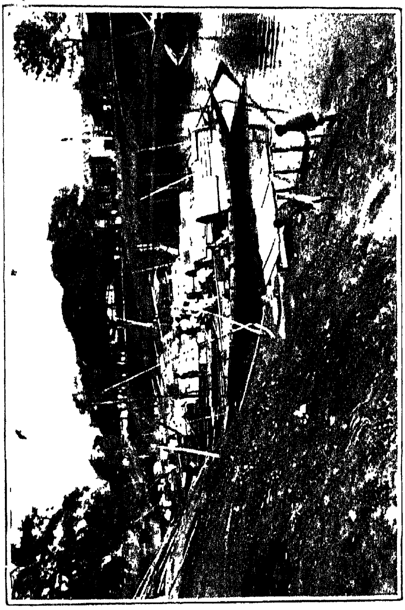


FIG. 2.—Wholesale market, Ultadanga Ghat.

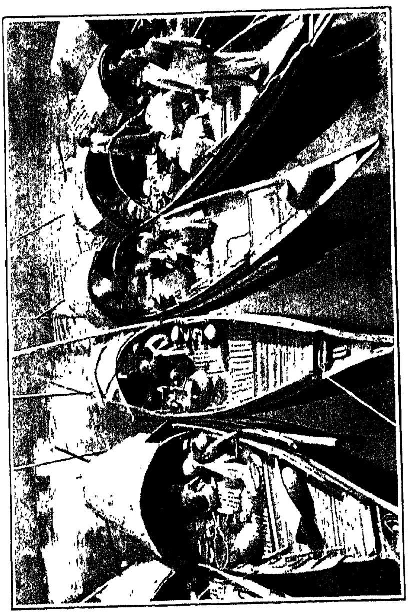


FIG. 3.—Boats at the Ghat after business hours.

FIG. 4.—Closer view of two boats.

Calcutta's Trade in 'Live Fish'.

FIG. 1.—Sale of *Jiol Machh.*

FIG. 2.—Closer view of sale of *Jiol Machh.*

FIG. 3.—*Jiol Machh* Section, Shambazar Market

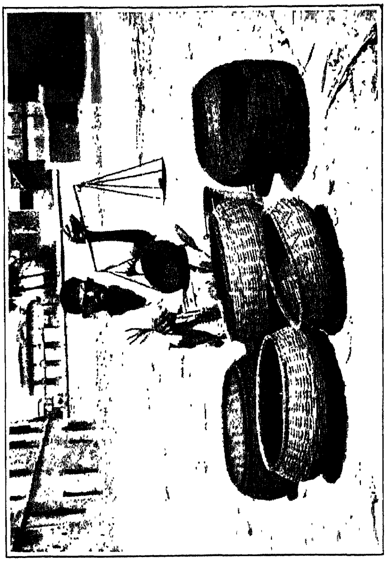


FIG. 4.—Temporary stall for sale of *Jiol Machh.*

Calcutta's Trade in 'Live Fish'.

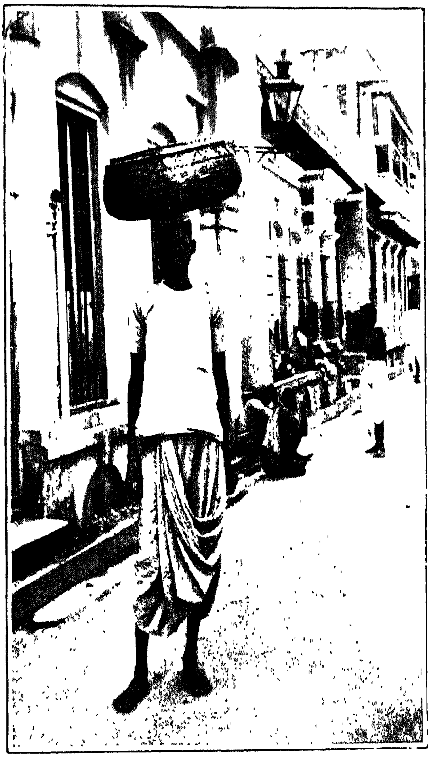


FIG. 1.—A Behari street-hawker of *Jiol Machh.*

FIG. 3.—*Jiol Machh* being carried home.

FIG. 2.—Behari street-hawker weighing *Jiol Machh.*

FIG. 4.—*Jiol Machh* being prepared for cooking.

Calcutta's Trade in 'Live Fish'.

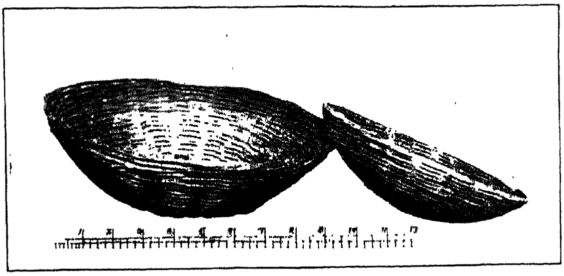


FIG. 1.—Fish measures—*Chhoto Jhāṇkā* and *Baṛo Jhāṇkā*.

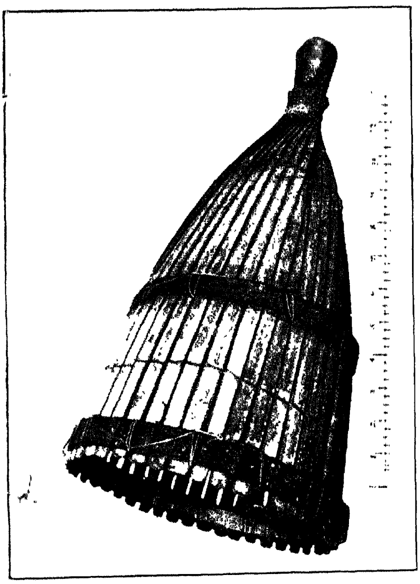


FIG. 2.—Large fish measure—*Dūrē*.

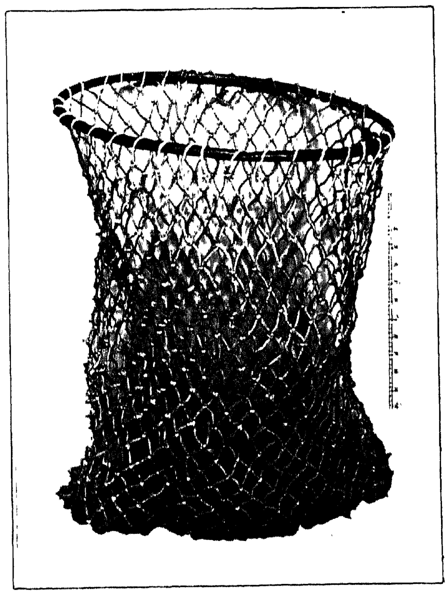


FIG. 3.—Net for taking out larger fish.

Calcutta's Trade in 'Live Fish'.

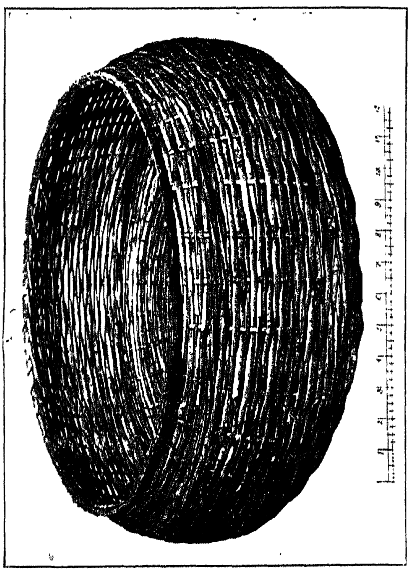


FIG. 1.—Large basket for carrying *Jiol Machh.*

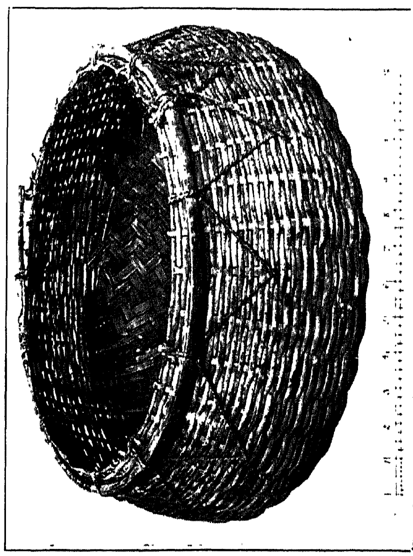


FIG. 2.—A large basket strengthened for durability.

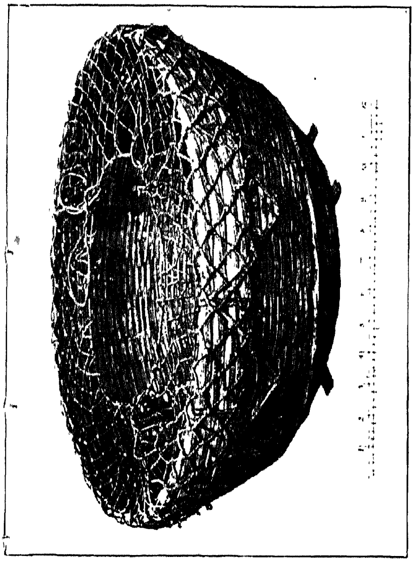


FIG. 3.—A large basket with a netting on the top.

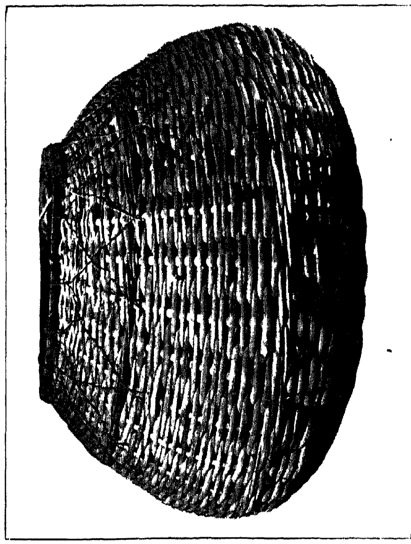


FIG. 4.—A narrow-mouthed large basket.

Calcutta's Trade in 'Live Fish'.

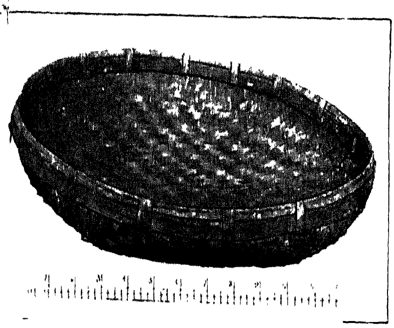


FIG. 1.—Flat basket used as cover.

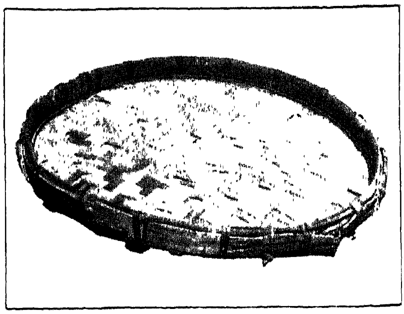


FIG. 2.—Flat basket used as cover.

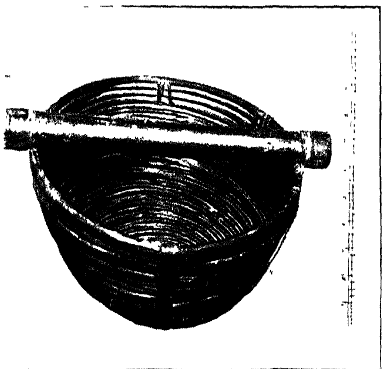


FIG. 3.—*Dhāmā*, used for bailing out water.

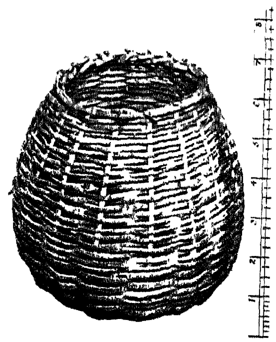


FIG. 4.—*Khāloi*, a small basket for general use.

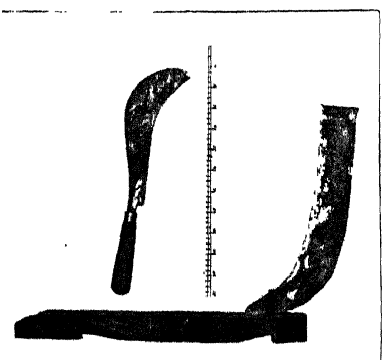


FIG. 5.—*Bonti* and *Katāri*, two types of knives.

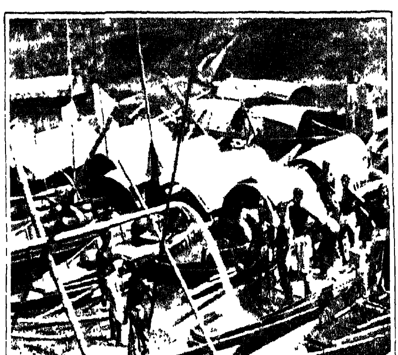


FIG. 6.—Taking fresh water in *Jiol Machh* boats at the Ultadanga Ghat.

Calcutta's Trade in 'Live Fish'.

Ecology and Bionomics of the Gobioid Fishes of the Gangetic Delta

by

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Zoological Survey of India, Calcutta

EXTRAIT DES COMPTES RENDUS
DU XIIe CONGRÈS INTERNATIONAL DE ZOOLOGIE — LISBONNE 1935

Casa Portuguesa — 139, Rua do Mundo, 141
LISBOA — 193C

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Ecology and Bionomics of the Gobioid Fishes of the Gangetic Delta

By Dr. SUNDER HORA (Calcutta)

(With 2 Figures and Plate XLVI)

SEWELL [1] in his account of the «Fauna of the Salt Lakes, Calcutta» described in some detail the physical conditions that prevail in the brackish waters of the Gangetic Delta, in regard to salinity, temperature, drought, silt, etc., and from a detailed study of the plankton remarked that «although in the main actual structural modifications are not discoverable, immigration into these estuarine regions and especially into the shallow water areas of the ponds and pools of the Salt Lakes has necessitated very great and striking changes in the physiology and the general habits of many of the inhabitants». In the case of certain fishes, however, especially the gobies, in addition to well marked structural modifications and change of habits physiological changes have come about as adaptations to the peculiar environmental conditions in this area. KEMP [2] discussed the modifications resulting from the silt-laden water and the soft and shifting substratum in colour and form of such bottom fishes as *Harpodon nehereus* (HAM.), *Polynemus paradiseus* L., *Coilia dussumieri* C. et V., etc., of the Matlah River. In addition, several other fish associations are found in the Gangetic Delta in which these and other ecological factors have induced structural and physical modifications. For instance, the rise and fall of the waters due to tides and the liability of shallow waters to evaporation have induced certain forms to breathe atmospheric air direct [3], while several animals estivate to tide

[1] SEWELL, Rec. Ind. Mus., XXXVI, pp. 45-121 (1934).
[2] KEMP, Rec. Ind. Mus., XIII, pp. 233-241 (1917).
[3] HORA, Trans. Nat. Inst. Sci. India, I, p. 13 (1935).

over the unfavourable weather conditions. These adaptations have also resulted in definite modifications of the gills and associated respiratory apparatus of the specialised fishes.

The fish fauna of the Gangetic Delta comprises a vast assemblage of species belonging to diverse families, the majority of which appear to be of marine origin. A few are immigrants from the fresh waters, but there appears to be no evidence of any true relic species in this fauna. Several marine species are also known to ascend fresh waters far above tidal influence in their periodic wanderings for breeding purposes and in quest of food.

Of the fishes that have established themselves successfully in the brackish waters, none are more interesting, ecologically, biologically and even morphologically, than the Gobioid fishes ; these exhibit striking and varied «adaptative radiations» in this area. The gobies, as is well known, form a large sub-order, of mostly small, carnivorous fishes. They are bottom-dwelling, coastal forms of tropical and temperate seas, and mainly frequent rocks between tide marks. There are, however, several species which enter rivers and streams, while quite a large number of them are found in fresh waters, especially on the oceanic islands of the Indo-Australian Region. Recently [4] attention was directed to the structural modifications exhibited by the Gobioid fishes of small torrential streams of some oceanic islands. These streams are usually so precipitous in their course that tides do not materially influence them and there is normally no sedimentation in their beds. In view of the above, I am of opinion that the Gobioid fishes of such streams established themselves in fresh water without passing through typical estuarine conditions. Accustomed to live on rocks in the surf-line, the Gobioid fishes became gradually adapted, by the mofications of their body form and pectoral and ventral fins, to withstand the swift currents of these torrential streams. It is a well known fact that due to heavy rains in the Indo-Australian and Indian Regions the shore waters at certain seasons become greatly diluted [5] and the littoral fauna, therefore, is as a whole,

[4] Hora, Acharyya Ray Commemoration Volume, pp. 92-99 (1932).

[5] Pelseneer, Bull. Acad. Roy. Belgique, N° 12, pp. 699-741 (1906).

already adapted to marked changes in salinity. In these circumstances, the gobies were particularly well adapted for colonising the lower reaches of the streams in this area.

The present report is the result of field work extending over three seasons on the brackish waters in the neighbourhood of Calcutta, mainly at Uttarbhag [6]. The biological observations made in the field were verified, in most cases, by keeping the animals in aquaria and watching their behaviour from day to day.

HAMILTON [7] described 16 species of Gobioid fishes from the Gangetic Delta, especially from the environs of Calcutta. I [8] have discussed the systematic position of these forms and have shown that they can be referred to 13 species belonging to as many genera — *Tænioides, Trypauchen, Apocryptes, Pseudapocryptes, Scartelaos, Boleophthalmus, Periophthalmodon, Glossogobius, Stigmatogobius, Gobiopterus, Ctenogobius, Eleotris* and *Butis*. Since HAMILTON's time several species of *Tænioides* have been described [9] from the estuaries near Calcutta and a new genus [10] — *Amblytrypauchen* — from the Sandheads. *Periophthalmus* is also known to occur in this region. During my work at Uttarbhag I did not find any specimen of *Trypauchen, Amblytrypauchen, Scartelaos, Gobiopterus* and *Periophthalmus*. *Gobiopterus*, which is known to live in waters of low salinity [11], is usually found in canals, lakes and other large pieces of stationary water. Its absence at Uttarbhag is, therefore, due to causes other than low salinity. With regard to *Trypauchen vagina* DAY [12] states that «It is a very common fish, and eaten by the lower classes.» In spite of special efforts to get specimens of this species at Uttarbhag, none were found and, so far as I am aware, this species is not obtainable in the Calcutta markets. The water of the Hooghly near Calcutta, as also of the Salt Lakes in its vicinity, is now

[6] For an account of Uttarbhag see HORA, Cur. Sci., I, p. 381 (1933).

[7] HAMILTON «Gangetic Fishes» (1822).

[8] HORA, Rec. Ind. Mus., XXXVI, pp. 483-490 (1934).

[9] DAY, Fish. India, p. 317 (1876).

[10] HORA, Rec. Ind. Mus., XXVI, p. 160 (1924).

[11] HORA, Rec. Ind. Mus., XXXVI, p. 488 (1935).

[12] DAY, Fish. India, p. 320 (1876).

almost fresh, but there can be no doubt that it used to be fairly brackish not very long ago [13]. It is presumably on account of the lowering of the salinity that this fish, as also *Scartelaos* and *Periophthalmus,* have disappeared from this area. *Eleotris macrodon* BL. and *E. amboinensis* BL. are stated to occur in the estuaries and mouths of large rivers in Lower Bengal, but I have not come across these species in the area studied.

In the following account I deal with the forms actually studied at Uttarbhag; this assemblage comprises representatives of 10 genera of diverse forms and affinities [14].

I. ECOLOGICAL FACTORS AND CLASSIFICATION OF HABITATS.

An account of the physical conditions that govern the life of brackish water animals at Uttarbhag has already been published, but it is desirable to reiterate the salient features. Uttarbhag is situated about 23 miles to the south of Calcutta, fairly low down in the deltaic region of the Ganges. It is situated on the western bank of the Piali Nadi, a tidal creek connecting the Bidyadhari and the Matlah rivers (see Text-figure 1). The rise and fall of the water in the Piali at Uttarbhag is approximately 15 feet and during the first phase of the high tide on the 13th of March 1933, its salinity was estimated to be 18.08 per mille. The Nadi is embanked on both sides, but in places there are narrow tunnels in the banks through which during flood tides water flows out from the Nadi to extensive fisheries alongside the banks. The flow of the water into the fisheries is controlled by narrow channels, and during ebb tides fishes are caught by laying traps at suitable places in the course of these channels. During ebb tides, the water in the small channels sinks to a very low level and the banks which are full of crab-

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[13] SEWELL (Rec. Ind. Mus., XXXVI, pp. 45-67, 1934) may be consulted with regard to the changes in the salinity of the Salt Water Lakes, Calcutta.

[14] I am grateful to Dr. B. PRASHAD for kindly reading through the manuscript, for making some suggestions and also for affording me facilities to carry out this work in the field. My sincere thanks are due to Mr. DEV DEV MUKERJI and Babu D. N. BAGCHI for helping me in various ways in the course of this work.

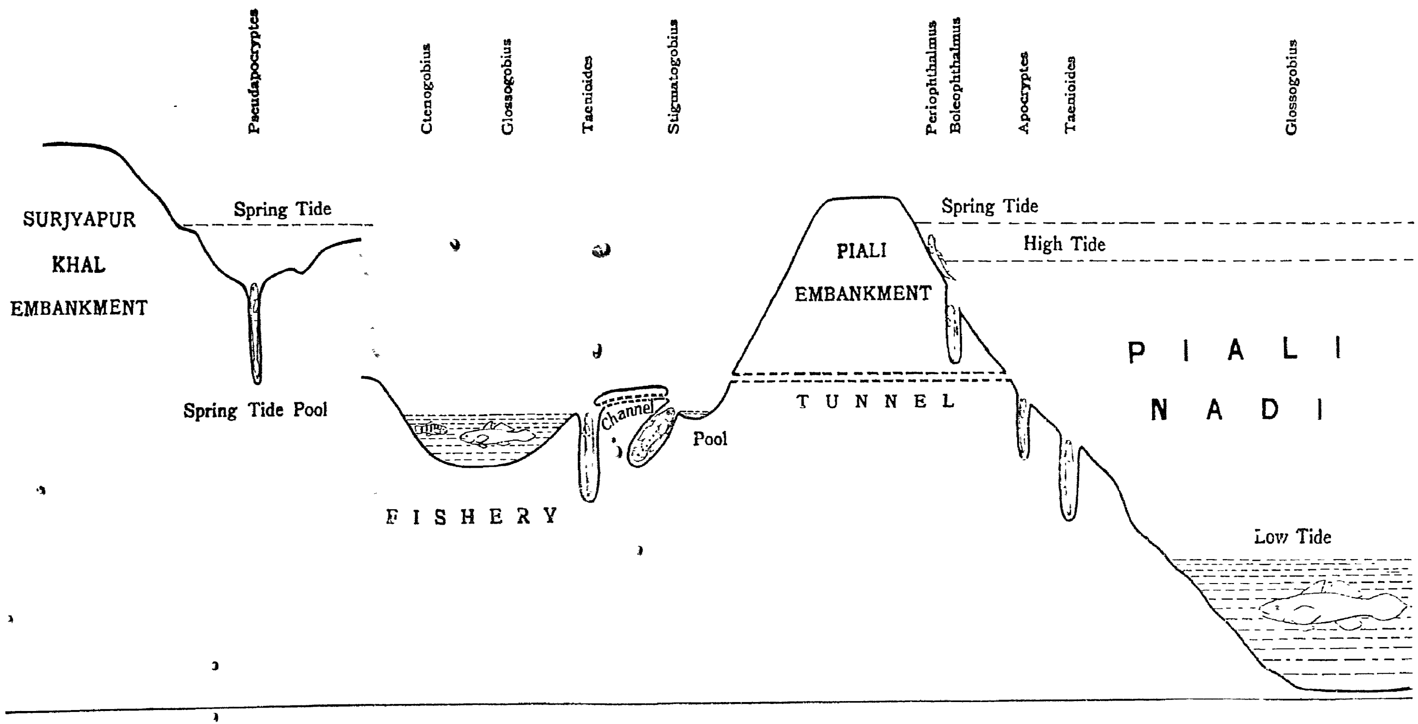


Fig. 1. — Diagrammatic representation of the habitats of Gobioid fishes as seen in a section of the Piali Nadi and connected waters at Uttarbhag, Lower Bengal. (The fishes are represented on a much larger scale than their habitats).

holes, etc. become exposed. In places the embankment of the Nadi is somewhat damaged so that during spring tide (full-moon and new-moon tides) the water flows over the embankment and floods large stretches of land containing depressions and pools of various sizes. In between the spring tides when the water from such places completely evaporates, the people scrape off the soil for the manufacture of common salt. Connected with the Nadi there are also canals and water-ways, the water level of which is controlled by lock-gates and sluices. During the rainy season, the whole of the area is flooded by fresh water and the salinity of the Nadi falls considerably, while the water in the connected channels and pools becomes almost fresh. At this time, the pool-animals breed and their eggs and young ones are carried away by the high tides to new grounds. The following principal fish habitats [15] may be recognised at Uttarbhag.

The Tidal Creek.

In any tidal channel three «associations» can be readily recognised: I) the bottom dwelling animals which are not materially affected by the tides, II) the animals that live between tide marks — they are immersed during flood-tides and exposed during ebb-tides — and III) the animals that live out of water and shift their position according to the condition of the tide. In Java, HARMS [16] found beach-gobies living in more or less definite zones and PEARSE [17] found a similar arrangement at Port Canning along the bank of the Matlah river. As regards gobies of the Paknam (Siam) belonging to the genera *Periophthalmus, Boleophthalmus* and *Glossogobius,* PEARSE [18] remarks that the three common species continually mingle together, but from the evidence of their size, food, length of intestine and types of parasites he concluded that «though these fishes lived together, they were not competing to any extent.» My studies

[15] HORA «Current Science» I, pp. 381-386 (1933). Photographs of different types of habitats are published here.

[16] HARMS, Zool. Anz., XLIV, pp. 35-42 (1914).

[17] PEARSE, Rec. Ind. Mus., XXXIV, pp. 289-298 (1932).

[18] PEARSE, Journ. Siam Soc., Nat. Hist. Suppl., IX, pp. 173-178 (1933).

have shown that the ten species of gobies found at Uttarbhag occupy definite zones and exhibit a well-marked ecological segregation. In the three «associations» of a tidal creek, for instance, *Glossogobius giuris* (HAM.), which is strictly aquatic, is found in water. *Apocryptes bato* (HAM.), *Tænioides rubicundus* (HAM.) and *Boleophthalmus boddœrti* (PALL.) are all found between tide marks; the first two live in deep burrows which contain water even during ebb tides, while *Boleophthalmus* lives in shallow puddles or burrows and is apparently more terrestrial in its habits. *Periophthalmodon schlosseri* (PALL.) is always found above water level.

According to PEARSE (*op. cit.*, 1933, p. 174), *Periophthalmus kœlreuteri* (PALL.), *Periophthalmodon schlosseri* (PALL.) and *Boleophthalmus boddœrti* (PALL.) «lived on the mud flats, the third usually somewhat lower down than the first and second, but all three went up and down together with the tides and even invaded the zone above high-tide mark, where they hunted for food among mangrove roots and hydrophytic plants.» This is true of *Periophthalmodon* at Uttarbhag, but not of *Boleophthalmus* which was only found below the high-tide mark.

The Fisheries.

The embankments of the Piali Nadi are, as noted above, tunnelled in places to feed the fisheries and the water is carried by narrow channels to extensive fishing ponds which, in some cases, are like small lakes (see Text-figure 1). The water rises in these fisheries during the flood tides and falls during the ebb tides; the rise and fall, though not very great, are sufficiently well marked to establish regular zones for the fishes. *Periophthalmodon* skips about along the water edge, *Tænioides* and *Apocryptes* are found near the periphery in shallow waters where the muddy bottom is devoid of vegetation. In the connected pools liable to dry up for long periods, *Pseudapocryptes lanceolatus* (BL. et SCHN.) is found living in deep burrows. This species is more commonly found in pools which are flooded during spring tides.

Near the edge of the pond, in certain places there is a profuse growth of vegetation. The small species *Ctenogobius nunus* (HAM.) is very common here. *Eleotris fusca* (BL. et

SCHN.) and *Butis butis* (HAM.) are also found in such places. The large aquatic goby, *Glossogobius giuris* (HAM.), is found in the deeper parts of the fisheries.

At the commencement of the narrow channels by which the fisheries are fed, there is usually a small pool, the banks of which are honey-combed with the holes of the crab *Varuna litterata* FABR. At ebb tide, when the water is low and the holes are exposed, people dig up quantities of *Stigmatogobius sadanundio* (HAM.) from such places. When spring tides incommode them, they leave the holes and are trapped in large quantities.

Spring-tide Pools.

Every fortnight there is a spring tide and the water of the Nadi rises very high and flows over the damaged portions of the embankment (see Text-figure I). Certain parts are flooded and the water lodges in pits and shallow pools. Between the spring tides, for a fortnight, these shallow pools are liable to extreme evaporation. In this process they are first converted into saline muddy water, then thick mud is formed, which on further evaporation leaves a dry cracked bed, below which there is a stratum of damp hard clay. The embankment is sometimes repaired or owing to drought the tides do not rise very high for long periods. Under these circumstances the pools dry up completely and the fauna is subjected to conditions of extreme drought. Of all these gobies, *Pseudapocryptes* which is found in large numbers in spring-tide pools, is best adapted to tide over such conditions. Occasionally, a few specimens of *Tænioides* and *Apocryptes* were also taken from these pools, though their normal habitat is different. Along the banks of the pools in crab holes, *Stigmatogobius sadanundio* (HAM.) was fairly common and above the water level *Periophthalmodon* was plentiful. *Pseudapocryptes* lives in burrows and during drought retires to a depth of about 6 feet, whereas *Periophthalmodon* and *Stigmatogobius* take shelter in crab holes and crevices during the dry period.

* * *

It is thus possible to arrange the ten species of the Gobioid fishes studied at Uttarbhag according to their habitats as follow:

Aquatic Forms

1. *Glossogobius giurus*:	Main channel, connected channels and fishery ponds.
2. *Ctenogobius nunus* 3. *Eleotris fusca* 4. *Butis butis*	Fishery ponds, mostly among vegetation and in shallow waters.

Semi-Aquatic Forms

5. *Tænioides rubicundus* 6. *Apocryptes bato* :	Low down on muddy banks between tide marks and in outlying shallow portions of fisheries.
7. *Stigmatogobius sadanundio*:	Crab holes along the banks of pools and narrow channels.
8. *Pseudapocryptes lanceolatus*:	Spring-tide pools.
9. *Boleophthalmus boddærti*:	Muddy banks between tide marks.

Almost Terrestrial Form

10. *Periophthalmodon schlosseri*:	Everywhere above water level.

The habitats are well defined and their ecological conditions are different, but it has to be remarked that in some cases the same species is found in more than one habitat as there are no rigid limits of demarcation. Even where two or more species live in the same habitat, such as *Ctenogobius nunus, Eliotris fusca* and *Butis butis* or *Tænioides rubicundus* and *Apocryptes bato*, their feeding habits are different, and there is, therefore, no competition for food; this results in a perfect ecological segregation of the different species.

It is clear from the above that the chief ecological factor in this environment is the ebb and flow of the tides. The aquatic gobies cannot withstand desiccation for long, though they can live out of water for a shorter or a longer period depending upon the humidity of the air and the dampness of the soil. Of the semi-aquatic gobies, *Pseudapocryptes* is the best adapted

to withstand drought, while the other three can endure drought-conditions only for a short period. *Periophthalmodon* however, can live for long periods in damp situations. Both the semi-aquatic and the terrestrial species have developed the power of breathing atmospheric air and the method of respiration [19] is similar in all the species with the exception of *Stigmatogobius*.

On account of the seasonal rise and fall in the salinity of water in this area, the fishes have become accustomed to a great range of variation in salinity. I have kept all these species in freshwater aquaria for days together without noticing any sign of distress. In this connection it may also be noted that the young of *Apocryptes, Pseudapocryptes,* and *Periophthalmodon* swarm in the river Hooghli at Calcutta during the rainy season, when the flood tides are very high.

For the burrowing forms, such as *Pseudapocryptes, Tænioides, Apocryptes,* the nature of the soil is also an important factor. The Uttarbhag soil, which contains a fair amount of colloidal matter, has a high water-holding capacity. This enables animals to live in the damp soil underground while the surface layers are baked dry. In this soil there is a fair amount of decomposed organic matter which not only renders the soil porous and light for burrowing operations, but provides nutrition to a number of mud-eating forms.

II. BIONOMICS.

The estuarine gobies of the genera met with in the Gangetic Delta have been the subject of considerable study. In recent years, SCHÖTTLE [20] and DAS [21] have worked on their anatomical and physiological adaptations for breathing in air and HARMS [22] has demonstrated that the relatively thicker skin of the terrestrial species is better adapted for conserving moisture.

The organs of progression in forms like *Periophthalmus, Periophthalmodon,* etc., which have been investigated by

[19] HORA, Trans. Nat. Inst. Sci. India, I, p. 13 (1935).
[20] SCHÖTTLE, Zeitsch. Wiss. Zool. Leipzig, CXL, pp. 1-114 (1932).
[21] DAS, Proc. Roy. Soc. London (B) CXV, pp. 422-430 (1934).
[22] HARMS, Zool. Anz., XLIV, pp. 35-42 (1914).

EGGERT [23] and HARMS (op. cit.), have been shown to be very well adjusted for locomotion on land. Several workers (DE BEER, ERDMANN, HESS, BAUMEISTER, HARMS, and SCHREITMÜLLER and RELINGHAUS) have studied the structure of the eye in mud-skippers and have found it to be better suited for distant vision than that of the fishes which live under water. PEARSE has investigated the food-habits of certain Siamese and Indian species.

In the following lines each species is treated separately and only new observations are recorded. For the sake of brevity, earlier literature is not reviewed or referred to except where my observations differ from those of the earlier workers. Though all the species dealt with below were studied as thoroughly as possible, more intensive work was done on *Pseudapocryptes lanceolatus*, a species which shows a wide range of physiological adaptations combined with a simplicity of structure.

All the species are capable of living out of water for a shorter or a longer period and their organs of aerial respiration are developed in connection with the buccal cavity and the gill-chambers. The air is taken in at the mouth and passed out through the gill-openings continuously in *Stigmatogobius*, *Eleotris* and *Butis*, while it is retained in the gill-chambers for some time in *Apocryptes*, *Tænioides*, *Pseudapocryptes*, *Boleophthalmus* and *Periophthalmodon* before expiration takes place. The gill-chambers have developed definite pouches for the storage of air and the gill-covers are specially modified to keep the openings tightly closed. *Glossogobius giuris* and *Ctenogobius nunus* are essentially aquatic species and were not observed to breathe air direct.

Another general point to which attention may be directed here is that all the species can live under water indefinitely provided the water is well oxygenated. Even forms like *Periophthalmodon*, which habitually live out of water and breathe air, have lived in my experiments for days together immersed in well oxygenated water [24]. *Tænioides rubicundus*, *Apocryptes bato*, *Pseudapocryptes lanceolatus* and *Stigmatogobius sada-*

[23] EGGERT, Zeitsch. Wiss. Zool., CXXXIII, pp. 411-440 (1929).
[24] HORA, Trans. Nat. Inst. Sci. India, I, p. 9 (1935).

nundio were mostly found in burrows and were not observed to come to the surface for breathing air. Aerial respiration is only resorted to during drought or under exceptional conditions of pollution of the water.

Changes in salinity do not incommode these fishes, as on several occasions specimens brought from Uttarbhag were kept in freshwater aquaria in the laboratory for long periods. Even at Uttarbhag the salinity varies considerably with different seasons, but it probably never rises above 20 per mille. Some of the species, however, are also found lower down in the Delta where the salinity is relatively higher.

It is thus seen that the Gobioid fishes of the Gangetic Delta have undergone remarkable physiological adaptations and in several cases the corresponding structural modifications are also well marked.

Aquatic Forms

Glossogobius giuris (Ham.)

Glossogobius giuris is the well known «*Bélé*» fish of Bengal and is the largest goby known. It is greatly relished as food and is one of the few species that migrate to sea for breeding purposes. In the Philippines there is a special fishery for the young of *Glossogobius giuris*. The range of the species extends from the east coast of Africa, through the seas, estuaries and fresh waters of India, to the Malay Archipelago and northwards to China.

G. giuris is a strictly aquatic species, and at Uttarbhag it is found in the Piali Nadi and other permanent pieces of water. It is somewhat tenaceous of life, but is not particularly adapted to live in foul waters. Its food consists of fish, shrimps, crabs and insect larvæ. The length of its alimentary canal, as pointed out by Pearse, is less than half the total length of the fish.

Ctenogobius nunus (Ham.)

Ctenogobius nunus is the smallest Indian goby growing to about 18 mm. in length ; it is commonly found in pools and

tanks of fresh and brackish waters in Lower Bengal, and its range extends from Puri on the Orissa Coast to Rangoon and Maulmein in Burma. I have always found it among vegetation where its banded coloration and transparent caudal fin make it inconspicuous. It feeds on planctonic crustacea and animal and vegetable growths on the stems of aquatic plants. The alimentary canal is a broad, simple tube with the stomach portion dilated and slightly bent in its posterior half; it is less than one-third the length of the fish. The species probably breeds in winter, as specimens collected late in December and early in January had ripe gonads.

Eleotris fusca (BL. et SCHN.)

Eleotris fusca is fairly common in the ponds and pools of Lower Bengal. At Uttarbhag only a few specimens from small fisheries are brought to the market. It lives in dirty, stagnant pools overgrown with vegetation and is very tenaceous of life. Its alimentary canal is simple; the walls of the stomach are thick and highly muscular. The length of the alimentary canal is about half the total length of the fish. In the specimens dissected the stomach was found to be empty, indicating that its feeding is probably intermittent. According to HERRE «it is evidently a voracious and indiscriminate feeder, specimens often being found with the stomach filled with vegetable tissues as well as with mollusca, crustacea and other fishes.»

E. fusca is widely distributed in rivers and other stretches of fresh and brackish waters near the sea; its range extends from the east coast of Africa, through India, to the Malay Archipelago and the Philippines.

Butis butis (HAM.)

In its habitat and habits *Butis butis* is similar to the preceding species; it is very rarely brought to the market at Uttarbhag. According to HERRE, this species is found in «both fresh and salt water, living in shallow bays, estuaries, and the lower reaches of rivers where they are more or less affected by the tides. They lie on the bottom or attach themselves to any object that will serve as a hiding place, their dark colours

blending with the environment so that they are almost invisible.»

Its alimentary canal, which is simple, is about three-fifths of the total length of the fish. The stomach was found to be empty in a number of specimens, but the lower part of the intestine contained fragments of shrimps, etc. In all probability, it also is a voracious and indiscriminate feeder. Its feeding also appears to be intermittent.

Butis butis is known to occur along the coasts of Bengal and throughout the Indo-Australian Archipelago as far as New Guinea. It ascends estuaries and tidal rivers.

Semi-Aquatic Forms

Tænioides rubicundus (Ham.)

The eel-like Gobioid fish *Tænioides rubicundus* (Ham.) is a very common species of the Gangetic Delta and at Uttarbhag large numbers of this fish are regularly brought to the market. It is locally known as «*Lal Ghagra*» or «*Lal Chaingua*» on account of its reddish colour. *Tænioides* is very tenacious of life and bites viciously at any object that may be near it with its strong and curved caninoid teeth, especially of the lower jaw. The fishes are sold alive in the market and are often found attacking one another when kept in a basket. Its tissues are soft, semi-transparent and almost gelatinous ; the fish decomposes rapidly after death. In its coloration, which is light dirty-brown above and red below, and general consistency the fish corresponds with the bottom-dwelling species of the Matlah River discussed by Kemp (op. cit.).

The habitat of *T. rubicundus* has been described above (*vide supra*, p. 849). Though a few specimens may stray into small spring-tide pools, the species is mainly restricted to the sloping, muddy banks of the Piali Nadi or its connected channels within tidal limits, usually much below the high water mark. It is also found in considerable numbers in shallow pieces of water, such as the peripheral areas of the fisheries, subjected to daily tides. On two occasions, specimens were dug up from below hard earth, but they were living in burrows (see Pl. XLVI 5) which extended considerably below the sub-soil level of water. My

observations show that it cannot stand drought for long. Specimens were kept in an aquarium half filled with the Uttarbhag soil and water. The fish made burrows, but when the water driep up, they died. The presence of *Tænioides* is readily detected from the characteristic, circular mounds of earth that surround its burrow. If such a burrow is watched for half an hour or so, clouds of mud are seen to issue from it at irregular intervals; these settle round the mouth of the burrow and give rise to the characteristic mounds. The clouds of mud indicate that the fish is burrowing deeper in the soil by biting at the earth and then blowing it out through the gill-openings. This process was observed by keeping the fish in an aquarium. Lumps of the hard Calcutta soil were provided, so that the fish had to bite hard to detach portions of them. If the detached portions were big, they were simply «coughed» out, but when the pieces were small, they were expelled with considerable force through the gill-openings. In the burrowing operation the head is rotated slightly, and the fish usually rests for a few minutes after burrowing hard for 2 to 3 minutes.

The stomach contents of a number of specimens were examined during February and March. At this season, the creeks are full of young *Mugil* and *Tænioides rubicundus* was found feeding on them voraciously. From the stomach of one specimen, as many as 24 young fishes and 2 shrimps were taken out. The length of the alimentary canal is about four-fifths of the total length of the fish: this shows that the fish is not herbivorous. It was never seen to chase its prey, but presumably its burrow acts as a snare for the fry and other small animals when the tide recedes.

A few very young specimens of *Tænioides rubicundus* were taken with tow-nettings from the Hooghly River at Calcutta during the rainy season. This indicates that the species probably breeds just before the commencement of the south-west monsoon.

Apocryptes bato (Ham.)

Apocryptes bato is also an eel-like Gobioid fish which is usually found associated with *Tænioides rubicundus* on the muddy slopes of the estuarine creeks. It lives in burrows within

tidal limits and, like *Tænioides,* cannot withstand drought conditions for a long period. Specimens kept in aquaria died as soon as the water dried up. The fish is soft and of a gelatinous consistency; it decomposes rapidly after death. Its habits of burrowing are similar to those of *Tænioides,* but it throws out finer mud which does not settle round the mouth of the burrow to impart to it a crater-like appearance.

Apocryptes bato is brought to Calcutta alive for sale and it is known as «*Saada Gulle*». At Uttarbhag it is familiar under the name «*Saada Chéng*». «*Saada*» refers to the uniform white colour of the species by which it is distinguished from the closely allied *Pseudapocryptes lanceolatus.*

Apocryptes feeds on mud and algæ; its intestine is narrow and greatly coiled. The length of the intestine is about twice the total length of the fish. Though *Tænioides* and *Apocryptes* live in close association, they do not compete for food. Usually *Apocryptes* lives at a somewhat higher level than *Tænioides,* and, comparatively speaking, is a hardy species.

During the rainy season, July to September, the young of *Apocryptes* were taken in tow-nettings at Calcutta in the Hooghly River. The species probably breeds with the first showers of the south-west monsoon and its young, which are carried up and down with the tides, are distributed all over the marshy areas. Some specimens establish themselves in the small channels that traverse the Calcutta Maidan and a few have been taken from the unfiltered water tanks in houses where they sometimes grow to a considerable size. During early stages, the fish feeds on micro-plancton.

Pseudapocryptes lanceolatus (Bl. et Schn.)

Pseudapocryptes lanceolatus resembles the preceding species in general facies, but can be readly distinguished by its characteristic mottled coloration and a series of bands on its lanceolate caudal fin. The habitats of the two species are very different. *Apocryptes* lives within tidal limits, whereas during the dry season, from November to May, *Pseudapocryptes* was found at Uttarbhag in spring-tide pools which dry up occasionally and sometimes remain dry for months together (see Pl. XLVI 1). It is a hardy species with thick skin and firm muscles.

In winter months, especially in October and November, the fish is brought to the Calcutta markets in large quantities and sold alive. It is known as «*Gulle Machh*» in Calcutta and «*Chéng*» at Uttarbhag. *Pseudapocryptes* makes deep burrows in which it lives, presumably with the head pointing downwards as clouds of fine mud are shot out at irregular intervals by the fish. It is an interesting sight to observe a pool, usually shallow and clear, containing burrows of *Pseudapocryptes*. At different places clouds are shot out and the colour of the mud determines the depth at which the fish is burrowing. For a foot or so, the mud is usually very black, but after that its colour becomes lighter. The mud is so fine that it does not settle round the opening to give it a crater-like appearance. On the 4th of March 1934, the surface temperature of a *Pseudapocryptes* pool, 4 to 5 inches deep near the edges and 9 to 12 inches deep in the centre, was 95° F (=35° C) at noon. The temperature of the bottom mud at a depth of one foot was 79.7° F (=26.5° C). It is possible that the fish burrows deeper and deeper to escape the excessive heat in the shallow pools.

When the pools dry up between the spring tides or for longer periods, the fish retire to depths of 5 to 6 feet in usually straight or slightly oblique, narrow burrows (see Pl. XLVI 3). In the absence of water, the burrowing is carried on by biting off lumps of soil and then «spitting» them out as pellets round the mouth of the burrow or along its walls (see Pl. XLVI 4). The lining of the burrow is smooth and shiny, due to the application of the slime of the fish as it goes up and down its wet burrow. Specimens kept on smooth, soft soil, burried their heads at once and remained in this position for a long time. I presume, the burrowing process is carried on at night when the walls are moist on account of dew which lies thick on the ground during the winter months. By February and March, when the spring tides do not usually rise very high, the fish become dormant in their burrows and lie with the head pointing upwards to facilitate aerial respiration. Specimens dug from a depth of six feet had a very small quantity of slimy water at the bottom of the burrow, but they were more or less torpid. When plunged in water they revived immediately and began to breathe water slowly, but regularly. In suitable aquaria, with a bed of Uttarbhag mud, the adult specimens burrowed to consi-

derable depths and were found lively even when the entire mud had dried up and cracked. The smaller specimens made shallow burrows and died after a few days. Some of these smaller individuals were induced to form burrows along the glass sides of the aquarium so that the behaviour of the fish could be observed (see Pl. XLVI 2). The specimens remained quiet so long as they were kept under observation, but at night formed small burrows and lay in them quietly with the head directed upwards. After 2 days when these individuals had become somewhat torpid, their burrows were gradually flooded. So long as the water was below the level of the anterior end of the fish, it showed no sign of revival, but as soon as the fish was immersed, it «coughed» out mud and began to breathe in water. In every case mud was «coughed» out when the burrows were flooded, indicating that the fish had used its mouth in digging.

The species breeds during the south-west monsoon when its burrows are flooded and is said to deposit large, black eggs at the bottom of the pools. During the monsoon, owing to the large volume of water, even the daily tides rise very high and the entire country is flooded. After hatching, the young *Pseudapocryptes* are carried by the tides into tidal channels and thus get widely distributed. During July, August and September, the Hooghly water at Calcutta is alive with these fish and at flood tide they enter into small channels of the Calcutta Maidan (Military Parade Grounds). Some of these specimens make burrows in suitable places and gradually grow to adult size. I have collected specimens from the Calcutta Maidan over six inches in length.

While cleaning a tank of unfiltered water-supply in his house, Babu D. N. BAGCHI collected several specimens of *Pseudapocryptes* from the bottom mud. This tank is thoroughly cleaned every third year and the specimens collected from it represented three annual growth stages. The youngest specimens from 13 to 16 mm. in length represented first year's brood, specimens about 50 to 80 mm. in length represented second year's brood, while the largest specimen about 150 mm. in length represented 3 years' growth. The diameter of the pipe feeding the tank is much smaller than the diameter of the

largest fish and there can be no doubt that the fish must have entered the tank in the young state.

The adult specimens, living in burrows, feed entirely on mud and their greatly coiled alimentary canals are about 2.6 to 2.8 times the length of the fish. ANNANDALE's observations on the bionomics and feeding habits of this species in the Malay Archipelago are not borne out by my experience, nor by an examination of the gut-contents. In the young stage up to about 20 mm. in length, the fish feeds on planctonic organisms, such as copepods, and the intestine is about 0.5 times the length of the fish.

Even in its very young stage, the fish is capable of both aerial and aquatic respiration. Specimens kept under aerated water and prevented from gaining access to the atmospheric air lived for a long time. Specimens kept in Petri dishes in a small quantity of water were found to be quite healthy even after a fortnight. The fish is very tenacious of life and can live for long periods without food.

Stigmatogobius sadanundio (HAM.)

Though this remarkable goby has been recorded from fresh and brackish waters of India, Burma, the Malay Peninsula, the Indo-Australian Archipelago and the Viti Islands, no worker has so far referred to its ecology or bionomics. From the records of several visits paid to Uttarbhag, it seems that *Stigmatogobius sadanundio*, the «*Narkulé Machh*» of the local people, is brought to the market for sale in small quantities during the spring-tide periods only. The fish is tenacious of life, as specimens in the market were being sold alive and, when kept moist, they continued to live for a considerable time after removal from water. The respiration consists of a continuous process of breathing air which is passed over the gills and lining of the buccal cavity and gill-chambers where oxygenation of the blood takes place.

Narkulé lives in crab holes, especially of *Varuna litterata* FABR., with which the banks of small channels and pools, by which the fisheries are fed, are liberally studded at Uttarbhag (see Pl. XLVI 6). Generally they do not move out of these holes and several specimens were dug out at ebb-tide. During

spring tides, their burrows are flooded and prolonged immersion under water presumably incommodes them: they then come out of their burrows and begin to wander about, mostly downstream, and are trapped in fairly large numbers. As a rule, this species is not subjected to prolonged droughts and is, in consequence, not as hardy as *Pseudapocryptes*.

Of the several specimens dissected, remains of amphipods were found in the stomach of one, while in the case of all others the stomachs were empty. Feeding thus seems to be intermittent. Amphipods are plentiful at Uttarbhag and at low tide they probably get entrapped in crab holes and fall an easy prey to *Stigmatogobius*. The alimentary canal of the fish is somewhat longer than the total length of the fish.

Boleophthalmus boddærti (PALL.)

Boleophthalmus boddærti is a very common estuarine goby; it lives on the muddy banks of the tidal creeks within tidal limits. At Uttarbhag, no specimen was taken from pools or ponds, but it was found to be fairly abundant along the banks of the Piali Nadi and connected channels subject to the full force of the tides. Though highly modified for aerial life, it is not as active as *Periophthalmodon*, and was never observed by me skipping about on muddy banks. It usually lives in shallow burrows containing small quantities of water, and feeds on algæ and diatoms. Its alimentary canal, as has already been shown by PEARSE, is about one and a half times the total length of the fish.

It is highly tenacious of life, and changes in salinity do not affect it to any marked degree. Being a species of the tidal zone, it cannot stand desiccation for long and it is not adapted to withstand prolonged drought.

B. boddærti is known to occur along the coasts and estuaries of India and Burma and its range extends to the Malay Archipelago.

ALMOST TERRESTRIAL FORM

Periophthalmodon schlosseri (PALL.)

Of the gobies that are found at Uttarbhag, *Periophthalmodon schlosseri* is the most terrestrial in its habits. It is never

found submerged under water and it is not uncommon to find specimens hopping about on dry beds of pools or on the banks of the channels above tidal limits. On one occasion, while digging the dry bed of a pool for specimens of *Pseudapocryptes lanceolatus* a specimen of *Periophthalmodon* was found at a depth of 3 feet. It was not found in a burrow and it seemed as if it had entered into a crevice of the cracked bed. Considerable literature has grown up regarding the ecology and bionomics of *Periophthalmodon* and *Periophthalmus*, but in spite of this the belief in the caudal respiration of these forms still persists even among ichthyologists. I have already indicated that this belief is not well founded, but it seems desirable to give further particulars here.

In 1886, at the Birmingham meeting of the British Association for the Advancement of Science, Dr. S. J. HICKSON advanced the view for the first time that in *Periophthalmus* the tail is used as a respiratory organ. He pointed out that the species he had observed in the Celebes always rested with its tail immersed in water, though the body was invariably out of water. His observations are included in «A Naturalist in North Celebes» (London: 1889, pp. 30, 31) and illustrated with a sketch [25]. In 1889, HADDON, in a note to «Nature», gave an account of the blood-supply to the tail region in *Periophthalmus* and felt justified in supporting HICKSON's observations on the caudal respiration of *Periophthalmus*. Since this date the view has been taken for granted by all writers of zoological text-books and popular books on fishes. It was, however, pointed out by RAUTHER and more recently substantiated by SCHÖTTLE that in *Periophthalmus* respiration is aerial ; the large gill-cavities are kept filled with air. This can be readily observed by keeping these fishes in an aquarium where they jump right out of the water and adhere to the sides. Every few minutes the gill-chambers are filled with air and bulge out considerably.

It seems probable that HICKSON's observations were made on the muddy banks of an estuary where *Periophthalmus* make shallow pits (ANNANDALE) in which the water lodges when the

[25] I have not seen HICKSON's book, but the sketch is reproduced in KYLE's «Biology of Fishes», p. 296, pl. XIII (1926).

tide recedes. Fishes often resort to this pit to moisten their body surface and are sometimes seen sitting round it with their tails in water. As is well known *Periophthalmus* is very quick of perception and the slightest disturbance on the part of the observer makes the fish skip away to a different position. When approaching a pool at Uttarbhag *Periophthalmodon* first went to the edge of the pool and oriented themselves in such a way that their tail portion was in water and their gaze was fixed on the observer. On approaching still nearer, the fish skipped along the surface and went to the other side of the pool. Ordinarily, the fish does not take to water. Such observations may have led HICKSON to the conclusion that the fish keeps its tail in water for respiration, but so far as the Indian specimens are concerned there is no truth in this belief.

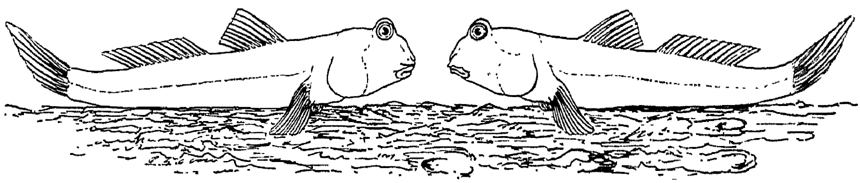


Fig. 2. — Two specimens of *Periophthalmodon schlosseri* (PALL.) in a fighting attitude.

Periophthalmodon schlosseri breeds during the monsoon months and a large number of young individuals are brought by the tides as high up as Calcutta. The habits of the youngest individuals I have examined, were similar to those of the adults. It is remarkable that though respiration is entirely aerial in its natural haunts, specimens kept in aerated water and prevented from coming to the surface lived for a number of days. For an hour or so they felt restless, but afterwards settled down at the bottom and the aquatic respiration became regular.

PEARSE has given an analysis of the food of this species. In the case of Port Canning specimens, the food consisted of spiders (13.0 %), insects (4.2 %), insect larvæ (2.0 %), shrimps (25.5 %), crabs (8.5 %), isopods (10.0 %), amphipods (1.0 %), ostracods (5.0 %), snails (9.5 %) and mud (21.3 %). In the case of Siamese specimens, the stomach contents consisted of flesh (7.5 %), crabs (21.0 %), insects (23.5 %), snails (5.0 %),

chætopods (13.5 %), plants (2.0 %) and mud (27.5 %). In the latter case, the alimentary canal was found to be less than half. I have dissected a number of Indian examples and found the alimentary canal to be a little over three-fifths of the length of the fish.

The varied menu of the fish is interesting, for it shows that the fish spares nothing that is likely to be found on the mud-flats. It can also jump up in the air to a height of few inches to catch flying insects.

Periophthalmodon lives in schools. The adults appear to be pugnacious, for sometimes when two of them happen to meet face to face, a hostile demonstration takes place (see Text-figure 2). In this attitude, the anterior part of the body is raised as high as possible on the pectoral fins, the dorsal fins are spread out like sails and the tail is directed upwards. In one case I watched the fight for nearly five minutes till the fighting pair was disturbed by an on-looker. During the fight, one of the fish caught hold of a pectoral fin of its opponent by its teeth.

Explanation of Plate XLVI

1. Almost dry bed of a spring-tide pool at Uttarbhag showing burrows of *Pseudapocryptes lanceolatus* (BL. et SCHN.).

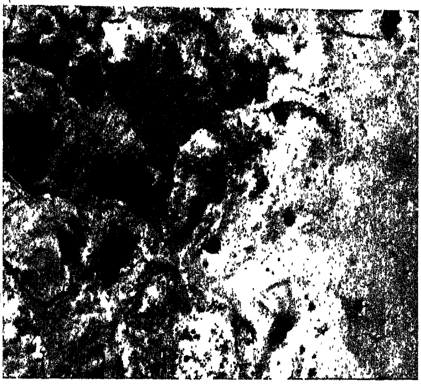
2. A young specimen of *Pseudapocryptes* estivating in a burrow made along the side of a glass aquarium.

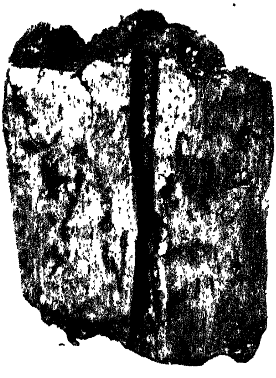
3. Bottom portion of a 6 feet deep burrow of *Pseudapocryptes*.

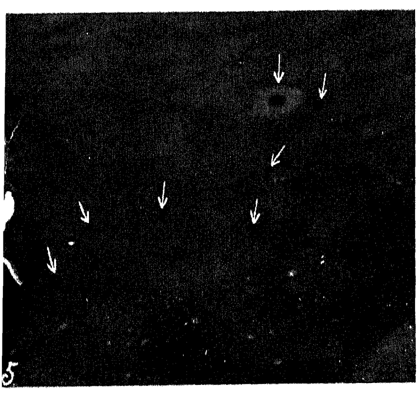
4. Pellets of mud on the walls of a burrow of *Pseudapocryptes* thrown by the fish in digging its burrow.

5. Shallow peripheral zone of a fishery at Uttarbhag showing burrows of *Tænioides rubicundus* (HAM.).

6. Pool at base of Piali Embankment showing burrows of the crab *Varuna litterata* FABR. which are sometimes inhabited by *Stigmatogobius sadanundio* (HAM.).



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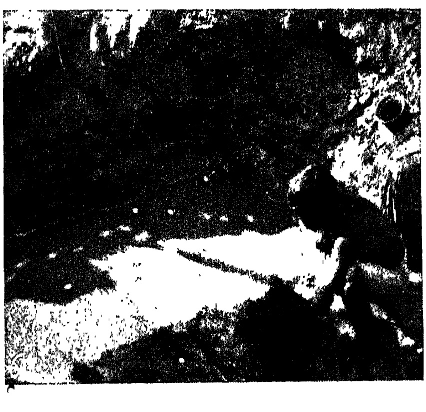

Reprinted from "Current Science", Vol. III, No. 8, February 1935, pages 336-338.

Modification of Swim-Bladder in Certain Air-Breathing Fishes of India.*

By Sunder Lal Hora, D.SC., F.R.S.E., F.A.S.B.,
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IN a general sense, the swim-bladder of fishes performs a hydrostatic function, but there are many structural anomalies which have neither been explained nor correlated with any variations in the habits of their possessors. In 1830, Taylor† directed attention to the modifications of the bladder in certain air-breathing fishes of India, but, so far as I am aware, these modifications have not been correlated with the habits of the fishes. For carrying out certain physiological experiments, several kinds of air-breathing fishes were kept in aquaria and it was observed that different species behaved differently when at rest. For instance, *Heteropneustes* (=*Saccobranchus*) floated in any position with its dorsal surface directed upwards; *Clarias* and *Amphipnous* floated vertically so long as their air-chambers were full of air; while *Ophicephalus* and *Anabas* did not float at all even after taking a fresh supply of air in their respiratory chambers; they lay quietly at the bottom for most of the time. For an explanation of their behaviour, I studied the form of their swim-bladder with the following results.

With the development of additional receptacles for the storage of air for respiration, it is evident that some adjustment of the hydrostatic organs had to take place. In *Clarias* and *Amphipnous*, the air-chambers are at the anterior end, and as the habit of these fishes is to lie suspended vertically for most of the time, they can keep the anterior end buoyant with the help of the air-chambers. A bladder in the abdominal cavity would have been a disturbing factor under the circumstances and is, therefore, either greatly reduced or lost altogether. *Ophicephalus* and *Anabas*, in spite of the extensive air-cavities in the head, are enabled to lie at the bottom by the extension of the swim-bladder in their caudal region. Thus the development of the buoyant chambers at the anterior end is balanced by the portion of the air-bladder enclosed in the caudal region. The long, dorsal tubes of *Heteropneustes* replace the ventral swim-bladder which becomes greatly reduced and enclosed in bone. The fish is enabled by the tubes to float or lie at the bottom, as the buoyant area is thus uniformly distributed all over the surface of the fish.

The study of the estuarine Gobioid fishes,‡ all of which are capable of aerial respiration under adverse circumstances, also leads to the conclusion that definite correlation exists between the form and position of the bladder and the mode of life of the different species. *Glossogobius giurus*, *Eleotris fusca*, *Butis butis* and *Stigmatogobius sadanundio* swim about freely and, though capable of living out of water for some time, are in the main water-breathing fishes and do not show any marked development of the gill-chambers. Consequently, the swim-bladder is extensive and of the normal type. *Pseudapocryptes lanceolatus*, *Apocryptes bato* and *Tænioides rubicundus* live in deep burrows, usually under water, and have developed large gill-chambers for aerial respiration under adverse circumstances. These eel-like fishes do not swim about and when the water is foul, they hang from the surface by distending their air-cavities (gill-chambers) with air. Under the circumstances, the bladder is of little use and, in consequence, it is greatly reduced. *Periophthalmodon*, *Periophthalmus* and *Boleophthalmus* are almost terrestrial in their habits and possess well-developed cheek-pouches for the storage of air. The air-bladder is absent in these genera.

From the above it is clear that the size and position of the swim-bladder in fishes are definitely correlated with their mode of life, and the structural modifications, referred to above, especially in the case of the fresh-water air-breathing fishes, are, no doubt, induced by the presence of air-chambers. These observations lend considerable weight to the view that the present chief function of the swim-bladder is to act as a hydrostatic organ, for where other structures have appeared to interfere with this

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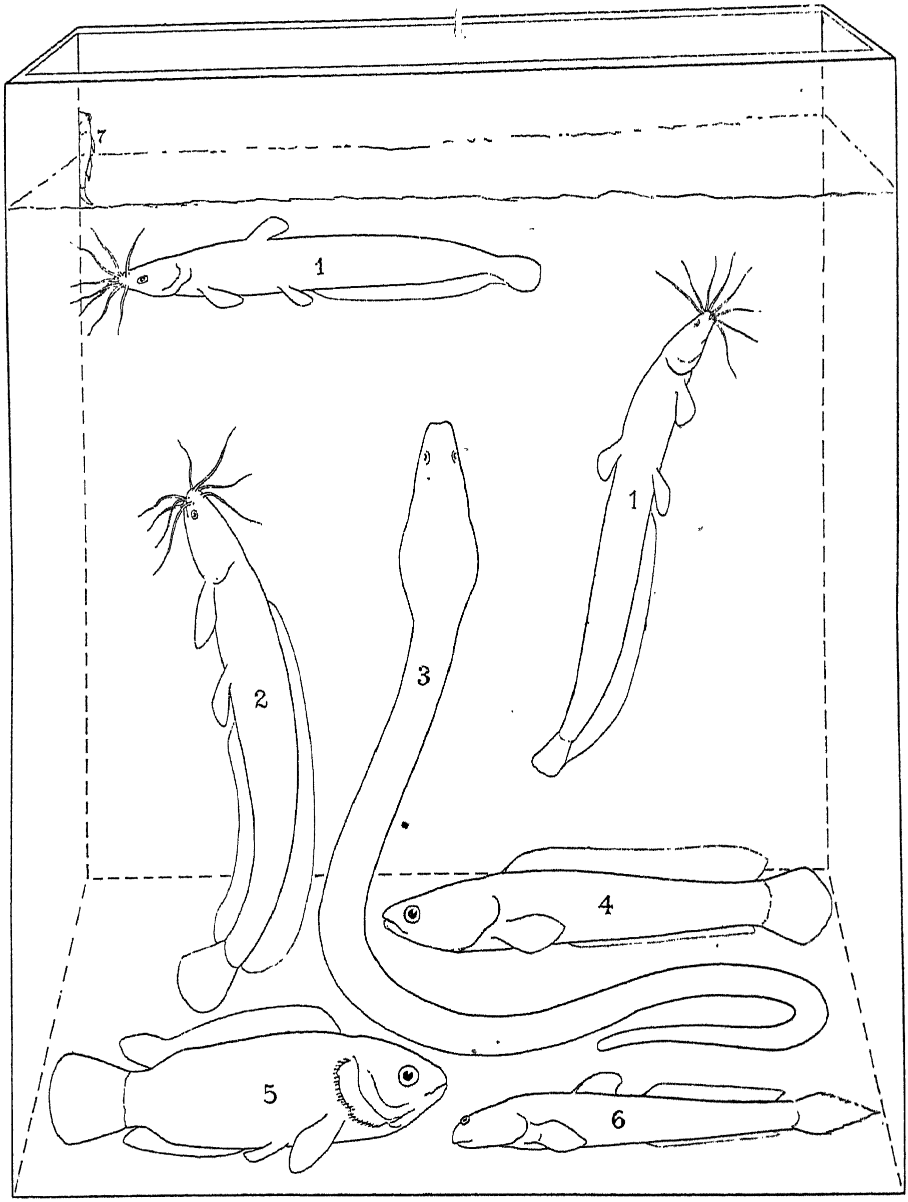
† Taylor, J., "On the Respiratory Organs and Air-Bladder of Certain Fishes of the Ganges," *Gleanings in Science*, 1830, **2**, 169-176.

‡ Mr. Dev Dev Mukerji of the Zoological Survey of India is at present engaged in investigating the correlation between the structure of the air-bladder and the ecological factors in the case of Gobioid fishes in the Gangetic delta.



Position at Rest of Certain Air-Breathing Fishes of India.

(Diagrammatic.)

1. *Heteropneustes fossilis.*
2. *Clarias batrachus.*
3. *Amphipnous cuchia.*
4. *Ophicephalus punctatus.*
5. *Anabas testudineus.*
6. *Pseudapocryptes lanceolatus.*
7. *Periophthalmodon schlosseri.*

function, the bladder has either disappeared functionally§ or has become greatly modified to meet the new requirements. The probable mode of origin of the type of air-bladder found in *Anabas* and *Ophicephalus* is discussed below.

The extension of the air-bladder in the caudal region among the Anabantidæ and the Ophicephalidæ is a remarkable morphological feature of these fishes. It has been indicated above that they are provided with extensive chambers in the head region for storing air for respiration and, in spite of these buoyant structures at the anterior end, they spend most of their time lying horizontally at the bottom. To reconcile these two facts, one has to imagine a type of fish before the development of the air-chambers. In an ordinary fish, the air-bladder is situated in the abdominal cavity and the fish is enabled to move up and down or lie at the bottom without feeling inconvenienced. The ancestors of the Anabantidæ and the Ophicephalidæ were probably bottom fishes. When they developed the habit of breathing air and storing it in cavities in the head, the anterior end became buoyant, so, for bottom life, they had to spend a great deal of energy to keep the front end down. Thus, such a fish had to swim almost constantly with the head directed downwards and the body inclined at an angle. Under these circumstances, the air in the air-bladder began to exert some pressure on the neighbouring ventral muscles of the caudal region which gave way and enabled the extension of the bladder backwards. This process must have continued for some time, till the buoyant tendencies of the anterior part of the fish were balanced by the extension of the bladder right up to the base of the caudal fin and it could lie at the bottom without any exertion.

The origin of the air tubes of *Heteropneustes* and of the air-bladder in fishes has to be traced to a similar habit. In the beginning, these structures probably developed as small pouches for storing air in the head region and when the anterior end became buoyant and the fish had to struggle for lying at the bottom, the backward extension of these pouches resulted in the setting up of the proper equilibrium. These observations lend support to the view that air-bladder probably developed as an organ of aerial respiration and that its present hydrostatic function is only a secondary acquisition.

§ *Clarias* and *Heteropneustes* (=*Saccobranchus*) are generally regarded as mud-inhabiting fishes of India. Though capable of living in mud when the water dries up, they are by no means mud-fishes, for they keep floating in water, usually near the bottom. It was under a misapprehension, therefore, that I (*Proc. 17th Ind. Sci. Cong.*, 1930, 229-243) attributed the reduction of the air-bladder in these fishes to a ground habit of life. The most plausible reason for the reduction of the bladder is to be found in the development of air-chambers and the floating habit of these fishes.

These observations show how identical modifications sometimes result from widely different causes, and, in consequence, the great need of field observations in the study of adaptations—correlation of form and habits. Cases are known of divergent modifications under similar environmental conditions (Hora, *Phil. Trans. Roy. Soc. London* (B), 1930 *a*, **218**, 266), and in the case of the reduction of air-bladder in fishes similar modifications have resulted from different causes. The result in all cases is the adjustment of an organism to the external conditions of its existence.

RECORDS

of the

INDIAN MUSEUM

Vol. XXXVIII. Part II. pp. 199 –23

Siluroid Fishes of India, Burma and Ceylon

II. Fishes of the genus *Akysis* Bleeker.
III. Fishes of the genus *Olyra* McClelland.
IV. On the use of the generic name *Wallago* Bleeker
V. Fishes of the genus *Heteropneustes* Müller.

By
SUNDER LAL HORA

CALCUTTA :
JUNE. 1936

SILUROID FISHES OF INDIA, BURMA AND CEYLON.

By Sunder Lal Hora, D.Sc., F.R.S.E., F.N.I., *Assistant Superintendent, Zoological Survey of India, Calcutta.*

II. Fishes of the genus *Akysis* Bleeker.

The genus *Akysis* is invariably included[1] in the family Amblycepidae and in my recent treatment of the fishes of the genus *Amblyceps* I[2] subscribed to this view. Since then, through the kindness of Dr. F. P. Koumans, I have obtained material of *Akysis variegatus* (Blkr.) and *Acrochordonichthys pleurostigma* (Blkr.) from the s'Rijks Museum van Natuurlijke Historie, Leiden. A study of these fishes has convinced me that they should be included in a separate family Akysidae, as had already been done by Weber and de Beaufort.[3] Unfortunately the osteology of these small fishes has never been studied and sufficient material is not available in the collection of the Zoological Survey of India to undertake this work. Regan[4] included *Akysis* and *Acrochordonichthys* in the family Amblycepidae on account of their edentulous palate and the resemblance of their air-bladder[5] and anterior vertebrae to those of *Amblyceps* and *Liobagrus*. The degenerate condition of the air bladder is not of much significance for considering genetic relationships as divergent forms are known to have undergone similar modifications due to a ground habit of life. The Amblycepidae (*Amblyceps* only) and the Akysidae (*Akysis*, *Acrochordonichthys* and *Breitensteinia*) can be separated by the following characters :—

Amblycepidae.	*Akysidae.*
1. Nostrils close together, separated by a nasal barbel.	Nostrils remote from each other, the posterior with a nasal barbel.
2. Dorsal and pectoral spines weak, articulated.	Dorsal and pectoral spines bony, strong.
3. Gill-openings wide extending very far forwards, gill-membranes united with each other across the isthmus and slightly overlapping.	Gill-openings narrow or of moderate width ; gill-membranes united with each other and with isthmus.
4. Skin smooth	Skin grannulated or tuberculated.
5. Flap of skin in front of base of pectoral present.	Flap of skin absent.
6. Air-bladder with thick walls. . .	Air-bladder with thin walls.

All the characters tabulated above, except perhaps the last two, are of considerable taxonomic value ; the position of the nostrils alone has been utilised by Weber and de Beaufort in separating groups of

[1] Regan, *Ann. Mag. Nat. Hist.* (8), VIII, p. 562 (1911) ; Jordan, *Classification of Fishes*, p. 148 (1923) ; Giltay, *Mem. Mus. Roy. Hist. Nat. Belg.* Hors Série, V, p. 30 (1933).

[2] Hora, *Rec. Ind. Mus.*, XXXV, p. 610 (1933).

[3] Weber & de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 365 (1913).

[4] Regan, *loc. cit.*, p. 562 (1911).

[5] Though of similar form, the air-bladder of *Amblyceps* is much more reduced, is thick-walled and has more pronounced modifications of the anterior vertebrae.

families of Siluroid fishes. It seems reasonable, therefore, not to include *Amblyceps* in the same family with *Akysis* and *Acrochordonichthys*.

As regards *Liobagrus*, I am not in a position to discuss its relationships, for there is no material of this genus in the collection of the Zoological Survey of India. There is an undoubted similarity between its skeletal characters and those of *Amblyceps*, but the widely separated nostrils and the absence of the skin-flaps preclude its union with the Amblycepidae. Jordan[1] included *Liobagrus* in Bagridae, but this requires further confirmation.

Of the family Akysidae, only *Akysis* has so far been found from within the limits of the Indian Empire. As early as 1883, a species—*A. pictus*—was described by Günther[2] from Tenasserim but since then no other specimen of it has ever been collected. In 1929, Prashad and Mukerji[3] referred 3 specimens from the Myitkyina District (Upper Burma) to a new subspecies of *A. variegatus* and remarked: "In the absence of any specimens of the two species referred to above [*A. variegatus* and *A. pictus*] for comparison, it is difficult to be definite about the specific position of this apparently new form". I have now compared the Myitkyina specimens with a paratype of *A. variegatus* and find that they represent a new species as already surmised by Prashad and Mukerji but unfortunately the new subspecific name—*variegatus*—they proposed cannot be retained. I now designate it as *Akysis prashadi*, sp. nov. and have thus great pleasure in associating it with the name of my chief Dr. B. Prashad. Prashad and Mukerji referred only to some salient features of the Burmese specimens and gave excellent figures of the lateral and ventral views of the type-specimen. The species is described below in detail and some additional figures are given.

For a long time the genus *Akysis* was known only from Java, Sumatra, Borneo and Tenasserim, but recent researches have shown that its range extends for a considerable distance northwards. Smith[4] recorded *A. macronema* and *A. armatus* from Siam and recently Fowler[5] has described two new species from the same country. Reference has already been made to Prashad and Mukerji's record of the genus from Upper Burma. It may be remarked that these small fishes are likely to be overlooked by casual collectors.

Akysis prashadi, sp. nov.

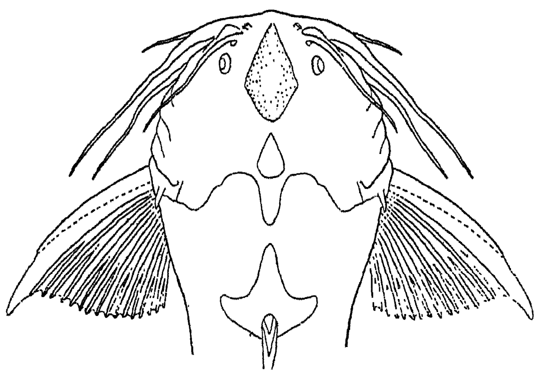
1929. *Akysis variegatus* subsp. *variegatus*, Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 180, pl. viii, figs. 1 & 2.

B. 6; D. 3/5; A. 11; P. 1/8; V. 6; C. 16.

Akysis prashadi is a small species in which the head and the anterior part of the body are flattened; the dorsal profile is somewhat arched while the ventral profile is almost straight and horizontal. The length of the head is contained from 3·8 (in the young) to 4·4 (in the adult)

[1] Jordan, *Classification of Fishes*, p. 148 (1923).
[2] Günther, *Ann. Mag. Nat. Hist.*, (5) XI, p. 138 (1883).
[3] Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 180 (1929).
[4] Smith, *Journ. Siam. Soc. Nat. Hist. Suppl.*, VIII, p. 180 (1931).
[5] Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVI, p. 97 (1934).

times in the total length without the caudal. The depth of the body is contained from 4·4 (in the adult) to 5·7 (in the young) times in the total length without the caudal. The width of the head is considerably greater than its length while the height is two-thirds (in the adult) to one-half (in the young) of its length. There are two broad median fontanels on the head ; the posterior is much smaller and terminates near the base of the occipital process. The eyes are small, dorsally situated and subcutaneous ; they are far forward in the anterior half of the head. The interorbital distance is equal to the length of the snout. The mouth is of moderate width, transverse and slightly overhung by the upper jaw. The lips are somewhat fleshy and papillated ; the labial groove is widely interrupted. There are eight barbels ; the nasals are considerably longer than half the length of the head and extend to the gill-openings ; the maxillary and the outer mandibular extend as far as the termination of the base of the pectorals or slightly beyond ; the inner mandibular reach to the base of the pectoral spine.

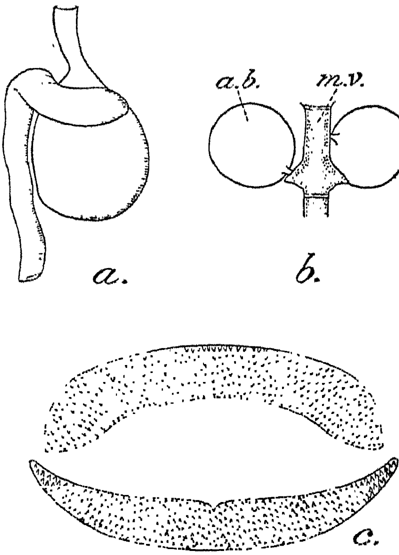


TEXT-FIG. 1.—Dorsal surface of head and anterior part of body of *Akysis prashadi*, sp. nov. × 2⅔.

The dorsal fin commences between the pectoral and ventral fins ; its long spine is preceded by 2 short spines, is grooved along the upper surface and is as long as the head behind the snout. The adipose fin is long and low ; its base is twice as long as that of the rayed dorsal. The two dorsal fins are separated by a short distance. The spine of the pectoral fin is not armed ; it is grooved along the upper surface and is as long as the head. The paired fins are horizontal. The ventrals extend beyond the anal opening but do not reach the anal fin. The caudal fin is emarginate, the lower lobe is slightly better developed than the upper. The caudal peduncle is twice as long as high.

The head is greyish, speckled with irregular black markings. Anteriorly the body is black in front of the ventral fins ; this black mark is contracted into a narrow streak which is continuous with another black area behind the ventrals and above the anal fin. Another black band connects this area with a broad black mark at the base of the caudal fin. The ventral surface of the body is speckled with irregular black markings. The proximal portion of the dorsal fin and a considerable part of the pectoral fins and of the adipose fin are black. There

is a black band across the middle of the caudal rays. The ventral and the anal fins are also streaked with black. The barbels are variegated with black. In the young specimens the three black marks on the body are discontinuous and not so wide. The general body colour is pale-olivaceous.



TEXT-FIG. 2.—Alimentary canal, air-bladder and dentition of *Akysis* Bleeker.

a. Alimentary canal of *Akysis variegatus* (Bleeker). ×3⅜ ; *b.* Air-bladder of *A. prashadi*, sp. nov. ×8¼ ; *c.* dentition of *A. prashadi*, sp. nov. ×25½.

a. b. = air-bladder ; *m. v.* = compound vertebra.

Length of specimen of *A. variegatus* 31 mm. without caudal.

Length of specimen of *A. prashadi* 28 mm. with caudal.

Localities.—Indawgyi Lake and round about Kamaing in the Myitkyina District, Upper Burma.

Type-specimen.—F. 10873/1, Zoological Survey of India (*Ind. Mus.*), Calcutta.

Remarks.—Prashad and Mukerji have already discussed the distinguishing features of this species. The larger number of rays in the pectoral (8 *versus* 5-7) and anal (11 *versus* 8-9) fins are very characteristic of *A. prashadi.* From *A. variegatus* it further differs in having two fontanels (instead of one) on the head. In *A. pictus* the nasal barbels are stated to be only half as long as the length of the head.

III. FISHES OF THE GENUS *Olyra* MCCLELLAND.

There appears to be considerable disagreement among ichthyologists regarding the systematic position of the loach-like fishes of the genus *Olyra* McClelland[1] which was characterised as follows :—

" Body soft, long, and cylindric, with two dorsals, the first radiated, the second adipose, head elongated and flat at the snout, operculum terminates behind in an oblique

[1] McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 588 (1842).

point directed towards the dorsal fins, anal long, caudal entire, teeth like velvet, confined to the jaws, no dorsal spine nor anything peculiar about the branchae; from six to eight slender cirri."

McClelland described two species in this genus from the Khasi Hills, Assam. Gill[1] restricted *Olyra* for the first species—*O. longicaudata*—and proposed a new genus *Branchiosteus* for the second species—*O. laticeps*. The two genera were distinguished on the number of the branchiostegal rays (6 in *Olyra*, 13 in *Branchiosteus*), the number of the anal rays (more than 20 in *Olyra*, 15 in *Branchiosteus*) and the number of rays in the ventral fin (5 in *Olyra*, 7 in *Branchiosteus*). Günther[2] recognised this division in his *Catalogue* but had no specimen of either of the species for examination. The two genera were included by him in the group Akysina characterised by a toothless palate and six rays in the ventral fin. In 1871, Day[3] described a new species of *Olyra* from the Pegu Yomas in Burma and emended the definition of the genus. According to the position assigned to this genus in his paper, it seems probable that he regarded it as a form allied to *Wallago* and *Silurus*. In his *Fishes of India, Olyra* is placed near *Pseudeutropius, Callichrous, Wallago* and *Silurus*; from the last three it is separated by the character of the adipose fin. In 1883, Günther[4] described from a number of specimens a new species of *Olyra*—*O. elongata*—from Tenasserim and emended the definition of the genus still further. He remarked that "the genus belongs to the group Silurina; and I should be inclined to place it in the vicinity of *Saccobranchus*." Vinciguerra[5] redescribed *O. elongata* from two examples and discussed at length the systematic position of *Olyra* and agreed with the contention of Günther. He also indicated that *O. laticeps* shows affinities with *Amblyceps* and may belong to that genus. Recent workers, such as Regan[6] and Jordan,[7] include *Olyra* among Bagridae and regard *Olyra* and *Branchiosteus* as synonyms. Chaudhuri[8] still further emended the definition of *Olyra* when he described a new species with a forked tail from Assam. This species was later recorded by me[9] from below the base of the Darjeeling Himalayas. I have already indicated that *Amblyceps horae* Prashad and Mukerji[10] from the Myitkyina District, Upper Burma, is a species of *Olyra*.

It would thus appear that the precise generic limits of *Olyra* and its position in the system of genetic classification are not clear. Judging from the short descriptions and figures of McClelland's two species

[1] Gill, *Proc. Boston Soc. Nat. Hist.*, VIII, p. 52 (1862).
[2] Günther, *Cat. Fish. Brit. Mus.*, V, p. 97 (1864).
[3] Day, *Proc. Zool. Soc. London*, p. 711 (1871).
[4] Günther, *Ann. Mag. Nat. Hist*, (5), XI, p. 139 (1883).
[5] Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2), IX, p.192 (1890).
[6] Regan, *Ann. Mag. Nat. Hist.* (8), VIII, p. 561 (1911).
[7] Jordan, *Classification of Fishes*, p. 148 (1923).
[8] Chaudhuri, *Rec. Ind. Mus.*, VII, p. 443 (1912).
[9] Hora, *Rec. Ind. Mus.*, XXII, p. 737 (1921).
[10] Hora, *Rec. Ind. Mus.*, XXXV, p. 609 (1933); also Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 819 (1933).

there seems hardly any doubt that the two forms are not congeneric. The main points of difference may be tabulated as follows :—

Olyra longicaudata.	*Olyra laticeps.*
1. Branchiostegal rays 6. .	Branchiostegal rays 13.
2. Pectorals 1/6. . . .	Pectorals 9.
3. Ventrals 5. . . .	Ventrals 7.
4. Anal 23.	Anal 15.
5. Jaws equal. . . .	Lower jaw considerably longer than upper.
6. Middle rays of caudal prolonged.	Caudal entire. [Truncate].
7. Dorsal fin opposite ventrals.	Dorsal fin between bases of pectorals and ventrals.

The absence of a rough spine in the pectoral fin[1], the large number of branchiostegal rays, the small number of anal rays, the unequal jaws and the forward position of the rayed dorsal in *Olyra laticeps* indicate that it is an *Amblyceps* as already surmised by Vinciguerra. The description is probably based on a young specimen of *Amblyceps mangois*, a very widely distributed and variable species[2], but until material of *Amblyceps* becomes available from the Khasi Hills it seems desirable to regard *O. laticeps* as a distinct species of *Amblyceps*.

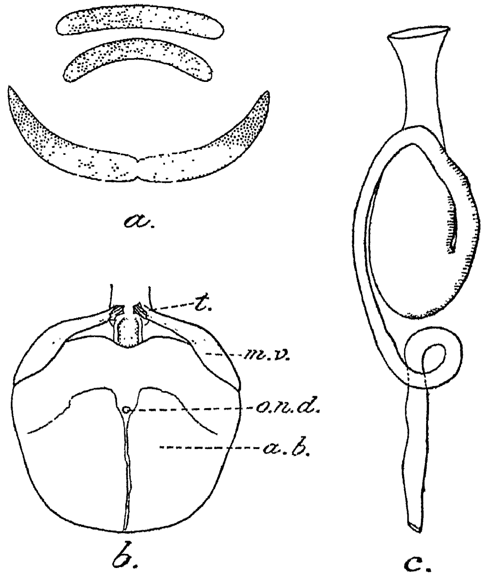
Having eliminated *O. laticeps*, it may now be possible to give a clear definition of the genus *Olyra* and to discuss its probable relationships.

The genus *Olyra* comprises small loach-like fishes in which the body is long and slender ; anteriorly it is somewhat depressed but in the tail region it is greatly compressed. The eyes are small, superior and subcutaneous. The nostrils are wide apart ; the anterior is tubular while the posterior is oval with a rim which is anteriorly produced into a long barbel. The mouth is small and anterior. The jaws are almost equal. The lips are thin and continuous. The labial groove is widely interrupted. Both the jaws are provided with a number of open pores. There are eight thin and long barbels ; one pair nasal, one pair maxillary and two pairs mandibular. The teeth are small, villiform and arranged in bands. The palate is provided with a broad, lunate band of teeth. The gill-openings are very wide and extend as far forward as the eyes ; gill-membranes are extensive and united with each other across the isthmus. There are 6-7 branchiostegal rays. The functional part of the gill-opening is greatly restricted while flaps of skins are developed along the lower edges of the gill-openings to act as valves for closing the openings. The chest is devoid of any adhesive apparatus. The dorsal fin is short with 7-8 rays but without a strong, bony spine ; it is situated opposite the ventrals. The adipose fin, though present, is short and low. The pectoral fin has a strong, serrated spine and about 4-6 rays. The ventral fins are small and horizontally placed. The anal fin is of moderate length, containing 16-23 rays which increase

[1] It is interesting to note that in the list of " Newly discovered species ", McClelland (*Calcutta Journ. Nat. Hist.* II, p. 574, 1842), uses the specific name ' *Olyra inermis* ' for ' *Olyra laticeps* '. The former name was not retained for the description of the species, but it shows all the same that the absence of an armed spine in the pectoral fins was regarded as a very characteristic feature of the species.

[2] Hora, *Rec. Ind. Mus.*, XXXV, pp. 607-621 (1933).

in length posteriorly. The caudal fin is long and lanceolate ; usually it is forked but in some species it may be entire. The anal-opening is situated midway between the ventral fins. The lateral line is present and complete. The air-bladder is fairly extensive and lies free in the



Text-fig. 3.—Dentition, air-bladder and alimentary canal of *Olyra* McClelland.

a. Dentition of *Olyra horae* (Prashad & Mukerji) × 5 ; *b.* Air-bladder of *O. longicaudata* McClelland × 3½ ; *c.* Alimentary canal of *O. longicaudata* McClelland × 2½.

a. b. = Air-bladder ; *m. v.* = modified vertebral element ; *o. n. d.* = Opening of pneumatic duct ; *t.* = tendon.

Length of specimen of *O. horae* 70 mm. without caudal.

Length of specimen of *O. longicaudata* 108 mm.

abdominal cavity though dorsally and laterally it is surrounded by thin wing-like extensions of the transverse processes of the complex vertebra. The walls of the bladder are fairly thick and a distinct pneumatic duct is present.

Type-species.—*Olyra longicaudata* McClelland.

As defined above the genus *Olyra* differs from the Bagridae in having a spineless dorsal and a peculiar type of air-bladder with the associated modifications of the anterior vertebrae. The anal fin is also relatively long. In many respects it is closely related to certain genera of the Siluridae, such as *Silurus*, *Silurichthys*, etc., but differs from them all in having a longer rayed dorsal, in the presence of an adipose dorsal and nasal barbels and in having a relatively shorter anal fin which is usually separated from the caudal by some distance. The presence of a relatively long, spineless, rayed dorsal and of an adipose fin, the depressed head and general facies indicate that *Olyra* may be a specialised hill-stream representative of the family Clariidae, sepecially of the section comprising *Heterobranchus*, *Dinotopterus*, etc. In view of

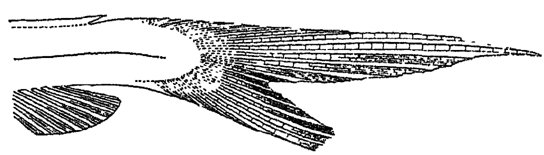
what is stated above and on account of the peculiar habitat and habits of *Olyra* it seems desirable to keep it, pending further investigation into the morphology of the so-called "degraded" genera of the Clariidae, in a separate family which may be designated as Olyridae and defined as follows :—

Body elongate, naked; gill-membranes free from isthmus. Dorsal fin with about eight rays and without a spine; adipose dorsal present; anal fin of moderate length containing 16 to 23 rays, never united with caudal which is usually long and filiform; ventrals 6-rayed. Anterior and posterior nostrils wide apart, posterior with long barbels. Barbels eight, one pair nasal, one pair maxillary and two pairs mandibular. Teeth small and villiform, arranged in bands in jaws and on palate. Vertebrae 48 to 53 (16-17 + 32-36). Lateral wing-like expansions of compound vertebra enclose air-bladder dorsally and laterally; air-bladder of moderate size, more or less free in the abdominal cavity.

The family comprises the genus *Olyra* only.

Reference should be made here to the close superficial similarity between *Amblyceps* and *Olyra*. The two genera can be distinguished externally by the position of the dorsal fin (between bases of pectoral and ventral fins in *Amblyceps* and opposite to ventrals in *Olyra*), the nature of the pectoral fin (with a broad flexible spine in *Amblyceps* and hard, rugged spine in *Olyra*). Internally the palate is edentulous in *Amblyceps* and provided with a broad band of villiform teeth in *Olyra*. In *Amblyceps* the air-bladder is greatly reduced and is divided into two lateral chambers, whereas in *Olyra* the air-bladder is of considerable size and lies free in the abdominal cavity.

In distinguishing species of *Olyra* considerable reliance is placed on the number of rays in the anal fin. This fin is usually enclosed in thick skin and to ascertain the full compliment of rays the skin has to be removed. In this way I have found that in *O. kempi* there are about 18 to 23 rays instead of 17-18 as described by Chaudhuri. In mature specimens of *O. kempi* the bifurcation of the caudal fin is not noticeable unless the fin is properly stretched. It seems to me highly probable that McClelland not only overlooked the bifurcation of the caudal fin in describing *O. longicaudata* but probably for the sake of symmetry regarded the "middle rays of the caudal prolonged to a lengthened point." Both in geographical distribution and taxonomic characters these two species are similar and it is likely that they are synonymous.



TEXT-FIG. 4.—Posterior part of tail and caudal fin of a typical specimen of *Olyra elongata* Günther. ×2.

Through the kindness of the authorities of the British Museum (Nat. Hist.), I have examined a typical specimen of Günther's *O. elongata*

from Tenasserim. The caudal fin is bifurcate, the upper lobe is considerably longer than the lower, which is due to "the prolongation of three rays of the upper half of the fin." If properly stretched, the fin is not lanceolate as described by Günther and later figured by Vinciguerra. I am convinced that this species is also identical with McClelland's *O. longicaudata.*

No specimen of *O. burmanica* Day is now available for examination either in the collection of the Indian Museum or in that of the British Museum (Nat. Hist.). As judged from its figure, it appears to represent a somewhat stouter fish. The caudal fin is shown as asymmetrically lanceolate (probably it is forked with some filiform rays in the upper lobe). *O. horae* is known from a single specimen in which the body is fairly stout and the upper lobe of the caudal fin is not very much longer than the lower.

It is thus clear that though six species have hitherto been described in this genus, only one species —*O. longicaudata* (=*O. elongata*=*O. kempi*)—is known from a large number of specimens collected at the base of the Darjeeling Himalayas, in Assam and Tenasserim. Until further material becomes available *O. burmanica* from the Pegu Yomas and *O. horae* from the Myitkyina District, Upper Burma, have to be regarded as distinct species, though it seems likely that they may also prove to be synonymous with *longicaudata*, as they fall within its range of geographical distribution. *O. laticeps*, as shown above, is a species of *Amblyceps*.

IV. On the use of the generic name *Wallago* Bleeker.

Under the vernacular name *Wallagoo*, Russell[1] described and figured a species of "Silurus" from Vizagapatam on the Coromandel Coast, but the fish had already been christened as *Silurus attu* by Bloch and Schneider.[2] Without assigning any reason Bleeker[3] used *Wallago* in the generic sense while describing a new species—*W. dinema*—from Borneo. Between 1851 and 1858, Bleeker[4] employed this generic denomination, still without any definition, for as many as eleven other Silurid fishes from India, Burma and the Malay Archipelago. There seems no doubt that the name had hitherto been used in a loose sense for in his first comprehensive revision of the Siluroid fishes Bleeker[5] restricted its use to two species —*W. russellii* Bleeker (=*W. attu* Bl. & Schn.) and *W. leerii* Bleeker— and proposed a new genus *Belodontichthys* for his *Wallago dinema.* Four years later in his *Atlas Ichthyologique*, he[6] fixed the limits of these genera more precisely by indicating their genotypes. All later workers have accepted the genus *Wallago* as ultimately restricted by Bleeker, and according to Weber and de Beaufort[7] the genus should date only from 1858 since "this is the first diagnosis of the genus, although the name *Wallago* was used by Bleeker since 1851, but without description."

[1] Russell, *Fish. Vizagapatam*, II, p. 50, pl. clxv (1803).
[2] Bloch & Schneider, *Syst. Ichth.*, p. 378 (1801).
[3] Bleeker, *Nat. Tijdschr. Ned. Ind.*, II, p. 202 (1851).
[4] Bleeker, *Nat. Tijdschr. Ned. Ind.*, II, p. 427 (1851); *ibid.*, V, p. 189 (1853); *ibid.*, V, p. 514 (1853); *Verh. Bat. Gen.*, XXV, pp. 54, 100, 108, 109 (1853).
[5] Bleeker, *Ichth. Arch. Ind. Prodr.*, I, Siluri, p. 259 (1858).
[6] Bleeker, *Atl. Ichth.*, II, p. 79 (1862).
[7] Weber & de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 200 (1913).

Jordan in his *Genera of Fishes* (pp. 247, 279) gives *Wallago dinema* Blkr. as the orthotype of *Wallago* and again the same species (*Belodontichthys macrochir* Blkr.=*Wallago dinema* Blkr.) as the orthotype of *Belodontichthys* Blkr. In accordance with the strict interpretation of the International Rules of Zoological Nomenclature *Wallago* should be used for species now included under *Belodontichthys* and a new generic name proposed for *Silurus attu* and its allies. But in view of the great familiarity of the generic name *Wallago* in its present accepted sense, I am retaining this name for *W. attu* and its allies. The matter will, however, be referred in due course to the International Congress of Zoological Nomenclature for inclusion of *Wallago* and *Belodontichthys* among the *nomina conservenda*.

The genus is represented by a single species—*Wállago attu*—in Indian waters.

V. FISHES OF THE GENUS *Heteropneustes* MÜLLER.

The genus *Heteropneustes* was established by Müller[1] to accommodate *Silurus fossilis* Bloch[2] of which he regarded *S. singio* Hamilton[3] as a synonym. Though the most important diagnostic character is stated to be the respiratory tubes as described by Taylor[4] in *S. singio*, Müller indicated that in external features his new genus was intermediate between *Silurus* and *Heterobranchus*. In the same year, Valenciennes[5] proposed the genus *Saccobranchus* for *Silurus singio* of which he regarded *S. fossilis* Bloch as a synonym. As the name implies, the main character of the genus is the presence of accessory respiratory sacs. Though *Saccobranchus* is a well known generic name among fishes, on grounds of priority, *Heteropneustes* must replace it, as pointed out by Müller[6] himself I have also looked up the original dates of publication of these genera and support this contention.

Valenciennes placed *Saccobranchus* near *Clarias* and *Heterobranchus* and remarked : " La ressemblance extérieure du crâne des Saccobranches avec les Clarias et les Hétérobranches dépend du développement des mêmes os ; ainsi, le crâne est élargi en avant par l'agrandissement des sous-orbitaires ; en arrière, par celui des mastoïdiens et des surtemporaux. La proéminence interpariétale fait une saillie sur l'occiput, sans qu'il y ait de casque ou de chevron sur les premiers interépineux. Les dents sont en velours aux mâchoires et sur deux plaques arquées au chevron du vomer. Les rayons branchiostèges sont au nombre de sept ; les barbillons de huit. De chaque côté des apophyses supérieures, et au-dessus du corps de vertèberes, existent deux sacs coniques, s'étendant jusqu'aux deux tiers de la longueur du corps, et ouverts en avant par deux orifices pratiqués sur le haut et entre les peignes des branchies." Bleeker[7] also regarded *Saccobranchus* a close

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[1] Müller, *Arch. Anat. Physiol.*, p. 115, 1839 (1840).
[2] Bloch, *Naturges. Ausländ. Fische*, VIII, p. 46, pl. ccclxx, fig. 2 (1794).
[3] Hamilton, *Fish. Ganges*, pp. 147, 374, pl. xxxvii, fig. 46 (1822).
[4] Taylor, *Gleanings in Science*, p. 170 (1830).
[5] Valenciennes, in Cuvier & Valenciennes' *Hist. Nat. Poiss.*, XV, p. 339 (1840). According to Sherborn [*Ann. Mag. Nat. Hist.* (9) XV, p. 600, 1925] volume 15 of *Hist. Nat. Poiss.* was published in November, 1840.
[6] Müller, *Abh. Kön. Akad. Wiss. Berlin*, p. 244, 1839 (1841).
[7] Bleeker, *Ned. Tidschr. Dierkunde*, I, pp. 119, 120 (1863).

ally of *Heterobranchus* and *Clarias* and included the three genera in his family Heterobranchoidei. At the same time he grouped these genera into two subfamilies, *viz.*, Heterobranchiformes for *Heterobranchus* and *Clarias* and Saccobranchiformes for *Saccobranchus*. Günther[1], however, included *Saccobranchus* in his group Silurina (for *Silurus* and its allies) under Siluridae Heteropterae and separated it from the other two genera which he placed under Clariina of Siluridae Homalopterae. This system was adopted by Day[2] and other ichthyologists, but challenged by Regan[3] on osteological characters. Regan brought back *Saccobranchus* under Clariidae though he kept it in a separate group within the family, as was done by Bleeker. Pape's[4] anatomical studies of *Saccobranchus* have thrown considerable light on the systematic position of the genus. According to him the skeleton shows that the fish is not only primitive in some respects but has certain features of both *Clarias* and *Silurus*. In view of these osteological details and on account of the fact that *Clarias* and its allies possess a totally different type of accessory respiratory organ it seems desirable that *Heteropneustes* should constitute a family by itself bearing superficial relationship to the Clariidae. Externally the members of the two families can be distinguished by the extent of their dorsal fin, which is short in *Heteropneustes* and usually very long in Clariidae. The new family Heteropneustidae may be defined as follows:—

Body elongate, compressed. Head greatly depressed, its dorsal and lateral parts covered with osseous plates. Gill-cavity with an accessory air-sac extending backwards into tail region. Cranial roof with occipital and frontal fontanels ; occipital part of skull prolonged into a process. Mouth small, terminal. Barbels 4 pairs, one pair nasal, one pair maxillary and 2 pairs mandibular. Nostrils wide apart, anterior tubular, posterior slit-like behind base of nasal barbel. Eyes small, lateral, with free orbital margin. Dorsal short, without spine, somewhat in advance of ventral. Adipose dorsal absent or represented by a low adipose ridge along posterior third of tail. Anal long, just reaching or united with caudal. Pectorals with a strong, ossesous spine. Ventrals six-rayed. Caudal almost rounded. Branchiostegals 7. Gill-openings wide. Gill-membranes separated by a deep notch, not united with isthmus. Teeth small, arranged in broad bands in jaws ; those on vomer in a patch on either side.

There is only one genus in the family represented by two species—*Heteropneustes fossilis* (Bloch) and *H. microps* (Günther). *H. singio* (Ham.) and *H. microcephalus* (Günther) are synonyms of *H. fossilis* (Bloch).

The range of the family, as known at present, extends from Ceylon, India and Burma to Cochin China. It is not found in the Malay Archipelago.

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[1] Günther, *Cat. Fish. Brit. Mus.*, V, p. 30 (1864).
[2] Day, *Faun. Brit. Ind. Fish.*, I, pp. 101, 102 (1889).
[3] Regan, *Ann. Mag. Nat. Hist.* (8), VIII, pp. 568, 569 (1911).
[4] Pape, *Jenaische zs. Natw.*, LII, pp. 445-520 (1914).

RECORDS

of the

INDIAN MUSEUM

Vol. XXXVIII, Part III, pp. 347—361

Siluroid Fishes of India, Burma and Ceylon.

VI. Fishes of the genus *Clarias* Gronovius.
VII. Fishes of the genus *Silurus* Linnaeus.
VIII. Fishes of the genus *Callichrous* Hamilton.

By
SUNDER LAL HORA

CALCUTTA:
SEPTEMBER, 1936

SILUROID FISHES OF INDIA, BURMA & CEYLON.

By SUNDER LAL HORA, *D.Sc., F.R.S.E., F.N.I., Assistant Superintendent, Zoological Survey of India, Calcutta.*

VI.—FISHES OF THE GENUS *Clarias* GRONOVIUS.

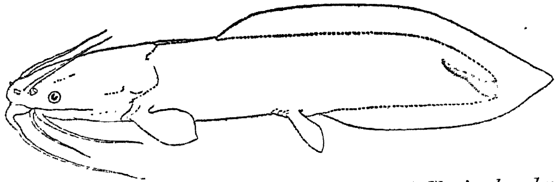
Günther[1] recognised four species of *Clarias* from India, Burma and Ceylon, *viz.*, *C. magur*, *C. teysmanni*, *C. brachysoma* and *C. jagur*. Day,[2] however, recorded five species from this region; of these three—*C. magur*, *C. teysmanni* and *C. jagur*—are the same as those listed by Günther. Day was doubtful regarding the validity of *C. brachysoma* and remarked: "Amongst the types of *C. brachysoma*, in the British Museum, the number of anal rays vary from 53 to 60, the fish appears to be similar to *C. Teysmanni*." A specimen obtained at Wynaad in Malabar was assigned by Day to *C. dussumieri* Cuvier and Valenciennes[3] and he described a new species, *C. assamensis*, from Assam. Both these forms were distinguished from the common Indian species, *C. magur*, by the form of the band of the vomerine teeth and their nature. In *C. dussumieri* (Day *nec* Cuvier and Valenciennes) the teeth are very obtuse, almost molariform, and form a continuous band; whereas in *C. assamensis* the teeth are globular and form two pyriform patches separated by a toothless space in the middle. Later, however, Day[4] discarded *C. jagur* as a separate species remarking that "*Macropteronotus jagur* of Hamilton Buchanan, Fish. Ganges, pp. 145, 374, appears to be a monstrosity of *Clarias magur*, in which the last few vertebrae have been accidentally lost or removed, and the new caudal fin has become continuous with the dorsal fin superiorly and the anal inferiorly."

I have examined a very large collection of *Clarias*, including several of Day's original specimens. Mr. P. E. P. Deraniyagala sent me a large collection, specially made for me, from Ceylon. Through the kindness of Mr. J. R. Norman information has been obtained regarding the distinguishing features of the types of *C. teysmanni* and *C. brachysoma*, now preserved in the collection of the British Museum of Natural History, London. The characters on which species are differentiated in this genus were tabulated with reference to the material in the Indian Museum with the following interesting results:

(i) In all the specimens examined, except one from Ceylon of *C. brachysoma*, including several hundreds in fresh condition in the Calcutta Fish Markets, the caudal fin was found to be distinct from the dorsal and the anal fins. The abnormal specimen from Ceylon is figured here. It shows the incomplete tail portion with the regenerated vertical fins. This supports Day's contention regarding *C. jagur*.

[1] Günther. *Cat. Fish. Brit. Mus.*, V, pp. 17-21 (1864).
[2] Day, *Fish. India*, pp. 484-486 (1877).
[3] Cuvier & Valenciennes, *Hist. Nat. Poiss.*, XV, p. 382 (1840).
[4] Day, *Faun. Brit. Ind. Fish.*, I, p. 115 (1889).

On referring to Hamilton's original notes on "Gangetic Fishes", it was found that *jagur* was obtained at Lakhipore in the Noakhali District.

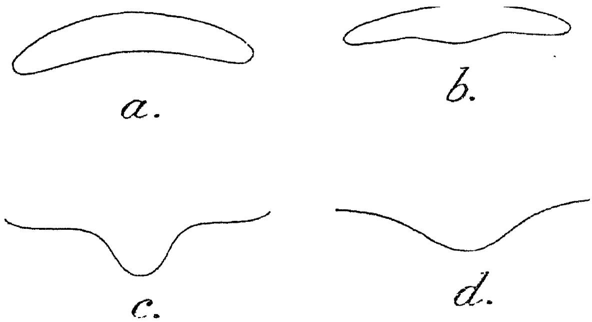


TEXT-FIG. 1.—Lateral view of an abnormal specimen of *Clarias brachysoma* Günther showing damaged tail region and regenerated vertical fins. $\times \frac{3}{8}$.

In the earliest known fish-manuscript of Buchanan[1] both the vernacular names "Magur" and "Jagur" are included under *Silurus batrachus* Linn. It would thus appear that Buchanan at first regarded the forms "Magur" and "Jagur" as pertaining to only one kind of fish, and considered this species to be the same as *Silurus batrachus* Linn. Later work has upheld the original determination of Buchanan.

It may be remarked that Bleeker (*vide* Günther, *op. cit.*, p. 19), observed an abnormal specimen of *C. melanoderma* in which the last rays of the dorsal and anal fins were united with the caudal. Deraniyagala[2] has also noted in the case of the common Ceylon species—*C. brachysoma*—that "specimens are frequently found with a regenerated caudal, which is then confluent with the dorsal and anal and lacks the hypural bones." In view of what is stated above I am definitely of the opinion that *C. jagur* is only an abnormality of *C. magur* (=*C. batrachus*).

(ii) The number of rays in the vertical fins varies considerably, and, therefore, no reliance can be placed on this character.



TEXT-FIG. 2.—Form of vomerine tooth-band and of occipital process in *Clarias teysmanni* Bleeker and *C. brachysoma* Günther. After sketches supplied by Mr. J. R. Norman. Diagrammatic.

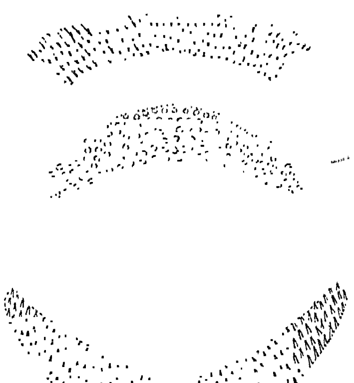
a. Vomerine tooth-band of *C. teysmanni*; *b.* Vomerine tooth-band of *C. brachysoma*; *c.* Occipital process of *C. teysmanni*; *d.* Occipital process of *C. brachysoma*.

(iii) Mr. J. R. Norman compared the specimens of *C. teysmanni* and *C. brachysoma* in the British Museum and found that the specimens from

[1] Hora, *Journ. As. Soc. Bengal* (N. S.), XXVII, 1931 p. 133 (1933).
[2] Deraniyagala, *Ceylon Journ. Sci.* (B) XVI, p. 279 (1932).

Ceylon listed by Günther under *teysmanni* are identical with the types of *brachysoma*. Further, he found that *teysmanni* from the East Indies is distinct from *brachysoma* of Ceylon. He says, "We have 7 specimens from Ceylon and 6 from the East Indies. The chief differences appear to be that *brachysoma* has a larger head[1] (4 to $4\frac{1}{3}$ in the length[2], instead of $4\frac{1}{3}$ to 5), the occipital process is broader and distinctly more obtuse,[3] the shape of the vomerine band of teeth is rather different, the frontal fontanelle is longer and narrower, and the distance between the occipital process to the dorsal fin origin is $2\frac{1}{4}$ to $2\frac{4}{5}$ in that from the former to the end of the snout instead of $1\frac{1}{2}$ to 2". I have verified these differences by comparing the specimens of *teysmanni* from Siam and Perak with a large number of specimens in the collection of the Indian Museum referred to this species from Ceylon. There are variations in detail, but the differences in the size of the head and the shape of the vomerine teeth differentiate very clearly *teysmanni* from *brachysoma*. The above observations show that there is an insular form of *Clarias* restricted to Ceylon and that *C. teysmanni* is restricted to the East Indies and the adjacent countries to the north.

(iv) *Clarias dussumieri* Cuv. and Val. from Pondicherry, and Malabar, was regarded by Günther as a *species inquirendum*. Jerdon[4] had found

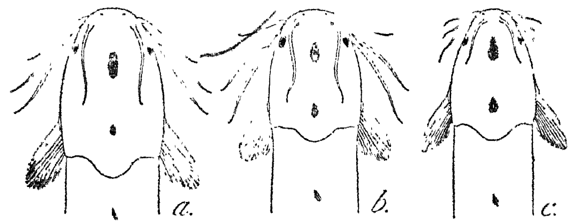


TEXT-FIG. 3.—Dentition of the type-specimen of *Clarias dayi*, sp. nov. ×4.

it fairly common in the tanks and ditches of Malabar but Day (*op. cit.*, 1877) was able to procure only one specimen (7 inches long) from Wynaad. Day also stated that "It appears to agree with Bleeker's Malay form" [*C. melanoderma* =*C. melasoma*]. The common species of Malabar is the same as that found in other parts of India and the collection before me leaves little doubt that Cuvier and Valenciennes' *C. dussumieri* is synonymous with *C. batrachus* (Linn.). Day's Wynaad

[1] Length of head is taken to the end of the occipital process.
[2] Length means length of fish without caudal.
[3] Mr. Norman found this character to be variable.
[4] Jerdon, *Madras Journ. Litt. & Sci.*, XVI, p. 342 (1849).

specimen is totally different. It not only possesses an externally serrated pectoral spine and molariform vomerine teeth, but its head is



TEXT-FIG. 4.—Dorsal surface of head and anterior part of body up to commencement of dorsal in the 3 species of *Clarias* from India, Ceylon and Burma.

a. Clarias batrachus (Linn.). $\times \frac{3}{8}$; *b. Clarias brachysoma* Günther. $\times \frac{3}{8}$; *c. Clarias dayi*, sp. nov. $\times \frac{1}{2}$.

considerably narrower, more or less pointed, the barbels are relatively shorter and the distance between the occipital process and the dorsal fin is $2\frac{1}{3}$ in that from the former to the end of the snout. It represents a species not hitherto described and I propose for it the name **Clarias dayi**, sp. nov. It is abundantly distinct from Bleeker's *C. melanoderma* and belongs to the group of species in which the commencement of the dorsal fin is at a considerable distance from the termination of the head, *e.g.*, *C. brachysoma*, *C. teysmanni*, etc.

(v) Day's *C. assamensis* is distinguished from *C. batrachus* by the disposition and form of the vomerine teeth, which are obtuse, and are

TEXT-FIG. 5.—Upper dentition of 6 specimens of *Clarias batrachus* (Linn.) showing variations in the nature of vomerine tooth-bands.

a. Specimen from Calcutta. $\times 2$; *b.* Specimen from Moulmein. $\times 2\frac{3}{5}$; *c.* Specimen from Inlé Lake, S. Shan States, Burma. $\times 1\frac{3}{5}$; *d.* Specimen from Dibrugarh, Assam. $\times 3$; *e.* Specimen from Assam. $\times 2\frac{3}{5}$; *f.* Specimen from Assam. $\times 3$.

situated in two pyriform patches. My examination of the extensive material of *C. batrachus* has shown that the vomerine teeth are not exactly villiform but are somewhat blunt as compared with the teeth of the jaws proper. The vomerine teeth are generally arranged in a broad crescentic band which is considerably wider than the maxillary band, but sometimes the band is narrower; the latter condition is commonly seen in specimens from Upper Assam and Northern Burma. Usually the vomerine teeth form a continuous band, but in some specimens, from widely separated localities, the band is partially or completely interrupted in the middle so that in extreme cases the teeth become

arranged in two pyriform bands. In very young specimens the teeth are few and arranged in two narrow, transverse patches.

Attention may here be directed to the fact that Bleeker (*vide* Günther, *op. cit.*, p. 19) also observed two specimens of *C. melanoderma* in which the band of vomerine teeth was divided into two by a toothless space in the middle.

In view of the above observations I am convinced that Day's *C. assamensis* cannot be regarded as distinct from the very variable and widely distributed *C. batrachus*.

Silurus anguillaris Russell,[1] *Clarias marpus* Cuv. & Val.[2] and *C. punctatus* Cuv. & Val.[3] are rightly regarded as synonyms of *C. batrachus*, of which *Macropteronotus magur* Ham.[4] is also a synonym.

In view of what is stated above, only three species of *Clarias* can be recognised from India, Burma and Ceylon. These may be distinguished by the following key:

A. Distance between tip of snout and end of occipital process *more than* 4 times the distance between dorsal fin and occipital process . . . . *C. batrachus* (Linn.).

B. Distance between tip of snout and end of occipital process *less than* 3 times the distance between dorsal fin and occipital process . . . .

a. Snout broad, pectoral spine *roughened* externally, nasal barbel longer than half length of head to end of occipital process . *C. brachysoma* Gthr.

b. Snout pointed, pectoral spine *serrated* externally, nasal barbel shorter than half length of head to end of occipital process . *C. dayi*, sp. nov.

Clarias dayi is known from the Wynaad hills, *C. brachysoma* from Ceylon and *C. batrachus* from India, Ceylon, Burma, the Malay Archipelago and beyond.

VII.—FISHES OF THE GENUS *SILURUS* LINNAEUS.

Earlier ichthyologists gave a very wide interpretation to the genus *Silurus*, but Bleeker[5] restricted it for forms like *Silurus glanis* Linn., and separated the other species assigned to it into a number of distinct genera.

Bleeker included *Silurus* in the subfamily Siluriformes and defined it as follows:

"Dentes maxillis palatoque. Cirri 6, supramaxillares 2, inframaxillares 4. Dentes maxillis pluriseriati. Caput depressum. Dentes vomero-palatini in vittam bipartitam dispositi. Oculi inferne liberi. Nares posteriores valvula claudendae, anteriores brevi-tubulatae. Pinna analis cum caudali unita. B. 15 vel 16. V. 1/10 vel 1/11. D. 4. P. 1/16."

At the same time he proposed the genus *Parasilurus* for *Silurus japonicus* Schl. (=*S. asotus* Linn.) and separated it from *Silurus* on the

[1] Russell, *Fish. Vizag.*, II, p. 53 (1801).
[2] Cuvier & Valenciennes, *Hist. Nat. Poiss.*, XV, p. 378 (1840).
[3] Cuvier & Valenciennes, *Hist. Nat. Poiss.*, XV, p. 384 (1840).
[4] Hamilton, *Fish. Ganges*, pp. 146, 374 (1822).
[5] Bleeker, *Versl. Akad. Amsterdam.*, XIV, p. 393 (1862); *Ned. Tijdschr. Dierk.*, I, p. 114 (1863).

(ii) Eyes free instead of subcutaneous and (iii) Vomerine teeth in a continuous transverse patch instead of being interrupted. Both Günther[1] and Day[2] did not consider these differences of generic value.

I have examined specimens of the type species of both the genera and, with the exception of the number of mandibular barbels (4 in *Silurus* and 2 in *Parasilurus*), have not found any difference of generic value between them. In the case of *S. asotus*, Günther (*loc. cit.*) found that " Some of the specimens show a distinct interruption in the middle of the band of vomerine teeth, whilst in others the bands are confluent." I have found similar variations of vomerine teeth in the case of the common Indian *Silurus*, *S. cochinchinensis.* To separate genera on the number of mandibular barbels[3] only in fishes in which this structure is presumably undergoing degeneration seems hardly justified, and I have, therefore, refrained from attaching much importance to this character in the case of Indian Silurid fishes.

Under the genus *Silurus*, Günther did not include any species from India with a sufficient degree of certainty. He observed, however, that *Silurichthys berdmorei* Blyth may probably be identical with *Silurus cochinchinensis.* In the case of *S. malabaricus*, which he included under *Silurus* with a querry, he remarked : " It is doubtful whether this species belongs to the genus *Silurus*, the short description given by Valenciennes having been taken from specimens in a bad state of preservation." In any case Günther, judging from the information published in his *Catalogue*, had no specimen of *Silurus* from Indian waters. Day[4] recorded *S. afghana* and *S. cochinchinensis* from India and described a new species from Wynaad[5]—*S. wynaadensis.* The former two species possess 2 mandibular barbels, while *wynaadensis* has 4 and is thus a typical *Silurus.*

Silurus malabaricus Valenciennes[6] is definitely known to belong to the genus *Callichrous*, while it is now possible to discuss the precise specific limits of the other species.

The differences between *S. afghana* and *S. cochinchinensis*, as indicated in Günther's descriptions, may be tabulated as follows :

	S. afghana.	*S. cochinchinensis.*
1.	D. 2 ; A. 70 ; P. 1/13.	D. 4 ; A. 62 ; P. 1/11.
2.	Anal and caudal slightly continuous.	Anal and caudal close together, but separate.
3.	Vomerine teeth in a very narrow, uninterrupted, curved band.	Vomerine teeth forming a band, which is a little interrupted in the middle.

It should be remembered that Günther had only one specimen of each species. An examination of a large series of specimens in the Indian Museum has given the following results with regard to variations in the above noted characters.

[1] Günther, *Cat. Fish. Brit. Mus.*, V, p. 32 (1864).

[2] Day, *Fish. India*, p. 480 (1877).

[3] Recent work on the embryology of *Silurus asotus* (Atoda, *Dolutsugaku Zasshi*, XLVII, p. 228, 1935 ; Kimura, *Journ. Shanghai Sci. Inst.* Sec. 3, III, p. 105, 1935) has shown that in the younger stages there are 4 mandibular barbels. In the course of growth, however, one pair of these barbels is absorbed.

[4] Day, *Proc. Zool. Soc. London*, p. 523 (1869) ; *Fish. India*, p. 481 (1877).

[5] Day, *Proc. Zool. Soc. London*, p. 237 (1873).

[6] Cuvier & Valenciennes, *Hist. Nat. Poiss.*, XIV, p. 353 (1839).

The dorsal fin is very small and enveloped in thick skin. In well preserved specimens the full compliment of rays can be made out only with great difficulty, while in lacerated specimens, especially from Cochin-China and the Mergui Archipelago, the rays can be counted with ease. The number of rays varies from 2 to 4 and in two adult specimens from the Naga Hills the dorsal fin is totally absent.[1]

The number of rays in the anal fin varies from 50 to 78, but in the pectoral fin the number is 13, besides a strong spine.

The anal and caudal fins are united, but not broadly confluent.

The vomerine teeth may form a continuous or discontinuous band, separated by a narrow or a wide interval. The condition of these teeth is thus similar to that noted by Günther for *Silurus asotus* (*vide supra*).

The study of the material in the Indian Museum has convinced me that the two species cannot be regarded as distinct. At my request

TEXT-FIG. 6.—Upper dentition of 3 specimens of *Silurus cochinchinensis* Cuv. & Val. from Lower Burma, showing variation in the nature of maxillary and vomerine tooth-bands. ×2½.

Mr. J. R. Norman very kindly compared the type of *S. afghana* with Günther's specimen of *S. cochinchinensis*. He confirms my views and states "I have carefully compared the type of *S. afghana* with the specimen identified by Günther as *S. cochinchinensis* and fully agree that, apart from the vomerine teeth, these are identical. I fully believe that the two species are synonymous, always provided that Günther's has been correctly identified". The specimens in the Indian Museum are from Lower Burma (Mergui Archipelago and Tenasserim), Upper Burma (Akyab, Myitkyina District), Naga Hills, Khasi Hills and Eastern Himalayas. It is not unlikely, therefore, that Günther's specimen from Cochin China was correctly identified. A specimen from the Myitkyina District was sent to Dr. Pellegrin for comparison with the type of *S. cochinchinensis*. He observed that in the type of *S. cochinchinensis* the vomerine bands of teeth are interrupted, and the dorsal fin equals half the length of the head, whereas in the Myitkyina specimen the vomerine teeth are in a continuous band and the dorsal fin in very rudimentary, about one-fifth the length of the head. In all other respects he found the two specimens absolutely identical. I have already shown that the vomerine teeth and the dorsal fin vary considerably in this species.

Günther based his description of *S. afghana* on a specimen 5 inches long in Mr. Griffith's collection and gave its locality as Afghanistan. From the geographical distribution of the species, as known at present, it seems highly improbable that the original specimen was collected in Afghanistan. A reference to Mr. Norman on this point brought the following reply: "I am unable to give you the precise locality of

[1] Hora, *Rec. Ind. Mus.*, XXXVIII, p. 319 (1936).

Griffith's specimen which formed the type of Günther's *Silurus afghana*. I have turned up the original register, but no details are given there. The old label on the bottle simply says 'Affghan'."

In the general list of specimens contained in Griffith's collection (*Calcutta Journ. Nat. Hist.*, II, pp. 573-575, 1842), McClelland has indicated the species of which examples were sent " to the Museum at the India House " by placing the number of specimens despatched in Roman numerals after the names. This list shows that McClelland sent specimens of three species of " Silurus ", *S. indicus* McClelland (one specimen), *S. glanis* Auct. (one specimen) and *S. boalis* Buch. (three specimens). The specimen of the first species is listed by Günther (*loc. cit.*, p. 46) under *Callichrous chedra* Ham., and the specimens of the last species (p. 37) under *Wallago attu* (Bl. & Schn.). It would thus appear that the specimen doubtfully referred by McClelland to *S. glanis* served as the type of *S. afghana*. Unfortunately the precise locality of this example is not indicated by McClelland but it is well known that Griffith made extensive collections in Assam, the Punjab and Afghanistan. No specimen of *Silurus* (*sensu stricto*) has since been found in north-western India and Afghanistan, while Günther's species is fairly common in streams below Darjeeling, Assam and Burma. It seems reasonable, therefore, to presume that there may have been some mixing up of localities in the case of the type-specimen of *S. afghana*. I[1] indicated the possibility of such a mixing up in the case of two species of *Nemachilus* which were stated to have come from Assam but which in reality belong to the Afghanistan fauna. It would, therefore, not be wrong to assume that the type of *S. afghana* was probably collected in Assam and not in Afghanistan.

Day[2] regarded *S. afghana* as distinct from *S. cochinchinensis* and separated them on the number of rays in the anal fin and the nature of the vomerine dentition. For *S. afghana* he gives Afghanistan and Darjeeling as the localities, while the distribution of *S. cochinchinensis* is given as " The hill ranges above Akyab, Tenasserim from whence Major Berdmore sent a specimen to the Calcutta Museum, and Cochin China ". At first he[3] referred Darjeeling specimens to *S. cochinchinensis*, then he[4] proposed a new species for them and ultimately called them *afghana*. This would indicate that Day was not quite sure about the precise specific limits of his specimens from Darjeeling. Day also observed that Jerdon presented some specimens to the British Museum " the largest of which is about 7·2 inches in length, the locality is not stated but they probably came from either the Cashmere or Assam regions." While examining Indian material of *Nemachilus* in the collection of the British Museum I[5] found a large number of specimens presented by Dr. Jerdon. These came from the Darjeeling Himalayas and Assam, and it seems likely that his specimens of *Silurus* also came from the same region.

[1] Hora, *Journ. As. Soc. Bengal*, (N. S.) XXIV 1928, pp. 481-484 (1929).
[2] Day, *Fish. India*, p. 480 (1877).
[3] Day, *Proc. Zool. Soc. London*, p. 711 (1871).
[4] Day, *ibid.*, p. 239 (1873).
[5] Hora, *Rec. Ind. Mus.*, XXXVII, p. 66 (1935).

The type of Blyth's *Silurichthys berdmorei*[1] is now preserved in the Indian Museum (Cat. No. 481). It is in a fairly good state of preservation except that the dorsal and the caudal fins are damaged. It agrees entirely with other specimens of *Silurus cochinchinensis.*

In 1861, Peters[2] described two new genera of Indian fishes from specimens collected by Westermann in 1847. No definite locality is mentioned though they are stated to have come from the "Ganges". The generic and specific limits of his first species—*Pterocryptis gangelica*[3], a Silurid fish—are very little understood; while his second species—*Acanthocobitis longipinnis*, a Cobitid fish—has been assigned to the genus *Nemachilus* and included in the synonomy of *N. pavonaceus* (McClelland) by Day.[4] Both Peters and Günther[5] regarded the latter species as a very close ally of the form described by McClelland. The above remarks would seem to indicate that Westermann collected his specimens somewhere in Assam or the Eastern Himalayas and this view receives further support from the fact that *Pterocryptis gangelica* is, as is explained below, a synonym of *Silurus cochinchinensis.*

In describing *Pterocryptis*, Peters only mentioned that his genus can easily be distinguished from *Cryptopterus* Bleeker[6] by its anal fin being continuous with the caudal fin. In the account of the species he mentions that the vomerine teeth form a continuous band which lies parallel to the maxillary teeth. The eyes are situated between the 1st and 2nd third of the length of the head. The maxillary barbels do not quite reach the pectoral fin while the mandibular barbels reach the end of the gill-cover. There are stated to be 12 branchiostegal rays and the fin formula is given as:

P. 1/12; D. 2; V. 1/9; A. 75; C. 15 (branched rays).

The total length of the type of *P. gangelica* is 95 mm., length of head 14 mm., breadth of head 9 mm., depth of body 10 mm. and the distance between the lower jaw and the anal fin 33 mm.

Günther (*loc. cit.*, p. 44) included Peters' species under *Cryptopterus*, but placed it in a distinct group characterised by "Anal united with caudal". Day,[7] however, assigned *Pterocryptes* to the synonomy of *Callichrous* and in the description of *C. gangeticus* remarked: "I have not procured this species in India, my nearest approach to it being *C. Sindensis.*" I have examined the type of *C. sindensis* and found that the union of the anal and the caudal fins is due to the regeneration of the caudal portion of the fish after some injury. In *Callichrous* the anal and the caudal fins are always distinct. Moreover, in *Callichrous* the depth of the body is never below one-sixth of the total length of the fish. The dorsal fin, though short, is fairly distinct and contains 4 to 5 well defined rays. These characters show that *Pterocryptes gangelicus* cannot belong to the genus *Callichrous*. On the other hand, its short description agrees very closely with specimens of *Silurus cochinchinensis*

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[1] Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 156 (1860).
[2] Peters, *Monatsb. K. Preuss. Akad. Wiss. Berlin*, p. 712 (1861).
[3] It is probably a misprint for *gangetica.*
[4] Day, *Fish. India*, p. 614 (1877).
[5] Günther, *Cat. Fish. Brit. Mus.*, VII, p. 348 (1868).
[6] Bleeker, *Ichth. Arch. Ind. Prodr.* I, Siluri, p. 283 (1858).
[7] Day, *Fish. India*, p. 476 (1877).

and I have not the least hesitation in regarding the two species as absolutely identical.

From the above it is clear that the genus *Silurus* is represented in Indian waters by two species—*S. wynaadensis* Day with four mandibular barbels from Wynaad and *S. cochinchinensis* Cuvier and Valenciennes with two mandibular barbels from the Eastern Himalayas, Assam and Burma. If the number of mandibular barbels is to be considered a character of generic importance, the generic name *Parasilurus* Bleeker will have to be replaced by *Pterocryptes* Peters.

VIII.—FISHES OF THE GENUS *CALLICHROUS* HAMILTON.

Hamilton in his "Gangetic Fishes" (p. 149, 1822) proposed the subgenus *Callichrous* for five species of *Silurus, viz., S. pabda, S. canio, S. duda, S. chechra* and *S. pabo,* and remarked that "species for this tribe of fishes are rather handsome, and have little or nothing of that lurid appearance by which many kindred species are distinguished. They are all very rich fine-flavoured food, and grow to from nine to twelve inches in length". No other generic diagnosis was given. Swainson[1] recognised *Callichrous* as a distinct genus and defined it as follows:

"Head large, depressed; mouth large, not vertical; dorsal fin close to the head; anal fin excessively long; vent close to the pectoral; caudal fin forked."

Besides the five species for which Hamilton used this name, Swainson referred to it *Silurus boalis* Ham. and *S. bimaculatus* Bloch. In 1862, however, Bleeker[2] defined the genus properly with *Callichrous pabda* Hamilton as its type. At the same time he included *Ompok* Lacépède and *Pseudosilurus* Bleeker[3] in its synonomy. The genus thus restricted was defined as:

"*Silurini.* Pinna dorsalis bene evoluta, hymenophora, spina ossea nulla. Dentes maxillis palatoque. Cirri 4, supramaxillares, inframaxillares. Oculi velati. Dentes maxillis pluriseriati setacei. Dentes vomerini in thurmas 2 distantes dispositi. Pinna caudalis biloba. B. 11 ad 15".[4]

This definition was somewhat amplified in his *Atlas Ichthyologique* (II, p. 84, 1862) and only *Pseudosilurus* was given as its synonym. In the discussion Bleeker erroneously thought that Hamilton had included *Silurus boalis* and *S. garua* among *Callichrous.* A year later Bleeker[5] in his "Systema Silurorum Revisum" again regarded *Ompok* Lac. synonymous with *Callichrous.* Günther[6] agreed with Bleeker, but regarded *Silurodes* Bleeker also as its synonym. Though *Ompok* as a genus is not included by Günther under *Callichrous,* its type-species is given in the synonomy of *C. bimaculatus.* Day[7] gave a much wider interpretation to *Callichrous* and included in its synonomy *Ompok* Lacép., *Kryptopterichthys* Blkr., *Micronema* Blkr., *Phalacronotus* Blkr., *Hemisilurus* Blkr., *Silurodes* Blkr., *Pseudosilurus* Blkr., *Silurichthys* Blkr., and

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1 Swainson, *Nat. Hist. Fish.*, etc., II, p. 306 (1839).
2 Bleeker, *Versl. Akad. Amsterdam*, XIV, p. 395 (1862).
3 Bleeker, *Ichth. Arch. Ind. Prodr.*, i, Siluri, p. 253 (1858).
4 The definition is drawn from the diagnostic characters given in the synoptic table of the Siluroid genera.
5 Bleeker, *Ned. Tijdschr. Dierk.*, I, p. 115 (1863).
6 Günther, *Cat. Fish. Brit. Mus.*, V, p. 45 (1864).
7 Day, *Fish. Ind.*, p. 475 (1877); *Faun. Brit. Ind. Fish.* I, p. 129 (1889).

Pterocryptes Peters. Weber and de Beaufort [1] have shown that *Silurichthys*, *Silurodes*, *Hemisilurus* and *Cryptoperus* (=*Kryptopterichthys*, *Micronema* and *Phalacronotus*) may be regarded as good genera, sufficiently distinct from one another and from *Callichrous*. I agree with this view though the difference between *Silurodes* and *Callichrous* is not of sufficient generic value as not only genera but species are known among Siluridae in which the vomerine teeth may be continuous or discontinuous. In the case of *Silurus cochinchinensis* I (*vide supra*, p. 353) have shown that such a condition can be regarded within the range of individual variation. As no species of *Silurodes* has so far been found in India, it is not possible to remark on its precise generic limits. I have shown in an earlier note that *Pterocryptes* Peters and *Parasilurus* Bleeker are synonymous with *Silurus* Linn. (*vide supra*, p. 355). *Pseudosilurus* is undoubtedly a synonym of *Callichrous* as repeatedly pointed out by Bleeker himself. The validity of the generic name *Ompok*, which has priority over *Callichrous* and, in the present state of our knowledge is known to be synonymous with it, may now be considered.

The genus *Ompok* was briefly characterized by Lacépède[2] as follows : " Des barbillons et des dents aux mâchoires ; point de nageoires dorsalis ; une longue nageoire de l'anus." Accompanying this short description are the figure and description of the type-species—*O. siluroides*, but both are very poor. The figure shows the following features which, if relied upon, indicate that the species cannot belong to *Callichrous* :

i. Total absence of dorsal fin.
ii. Rounded caudal fin.
iii. Small eyes above the level of the angle of the mouth.

Judging from the figure alone, the species would appear to resemble *Apodoglanis* Fowler[3] known from Borneo, except that the latter lacks the ventral fins. But very fortunately the type-specimen of *Ompok siluroides* was examined by Valenciennes[4] with the following results given under *Silurus bimaculatus* Bloch :

> " C'est sur un poisson appartenant à ce groupe, et probablement à cette espèce, mais très-mal conservé, et encore plus défiguré par le dessinateur, que M. de Lacépède a établi son genre *Ompok* et son espèce *Ompok siluroïde* (tom. V, pag. 50 ; et tom VI pl. 1, fig. 2) le Muséum possède encore l'individu qui lui a servi; il est desséché en herbier, et j'ai retrouvé la dorsale, qui était repliée par derrière et avait échappé ainsi à l'auteur. C'est l'absence prétendue de cette nageoire qui avait fourni le caractère du genre, lequel, par conséquent, tombe de lui-même.
>
> " Cet individu a soixante-trois rayons à l'anale et la caudale divisée ; mais ses autres caractères ne peuvent être déterminés."

Bleeker[5] also discussed the validity of the genus *Ompok* and came to the conclusion that—

> " Le nom d'Ompok aurait droit de priorité sur ceaux de Callichrous et de Pseudosilurus, mais ne reposant qui sur une erreur et n' étant qu'une reproduction mutilée nom malais Limpok, j'ai cru devoir n'adopter que le nom proposé par l' auteur des Poissons du Gange ".

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[1] Weber & de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 207 (1913).
[2] Lacépède, *Hist. Nat. Poiss.*, V, p. 49 (1803).
[3] Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, p. 463 (1905).
[4] Cuvier & Valenciennes, *Hist. Hat. Poiss.*, XIV, p. 362 (1839).
[5] Bleeker, *Atlas Ichthyol*, II, p. 85 (1862).

Later authors did not question these views and even Weber & de Beaufort (*op. cit.*, p. 207) in accepting the genus *Callichrous* remark that Lacépède's diagnosis of the genus *Ompok* is erroneous. Jordan [1] has, however, disagreed with all the previous workers and thinks that *Ompok* should replace *Callichrous*. He assigns no reasons for this change. American ichthyologists are now frequently using the name *Ompok* in preference to *Callichrous*, but in view of the evidence adduced above the change does not seem to be justified.

In *Callichrous* the anal fin is long and may be free (several species) or just united with the caudal (*C. leiacanthus*) which is always forked. *Callichrous sindensis* Day[2] is an exception in these respects. In this species the anal fin is said to be broadly united with the caudal, which has a curved, entire margin. The type-specimen is now preserved in the collection of the Indian Museum and its careful examination shows that the caudal portion of the fish is regenerated after some injury. It seems likely that the tail fin along with a small portion of the tail was bitten off by another fish and that, during regeneration, the anal fin became extended round the injured part. This would also account for the smaller number of anal rays (47) in this specimen. Deraniyagala [3] has also observed that in the case of certain Ceylonese specimens of *C. bimaculatus* the caudal fin "is at times found to be regenerated and is then confluent with anal."

Other important characters mentioned by Day for *C. sindensis* are that the cleft of the mouth is very oblique, the lower jaw is very prominent and the eye is situated rather above the angle of the mouth. These features of the specimen are due to the fact that it is somewhat pug-headed. Pug-headedness is not uncommon among Siluroid fishes, and I have found such examples in a number of species. In view of the above I am of opinion that *C. sindensis* Day represents an abnormal, pug-headed specimen of *C. bimaculatus* (Bloch).

It has been shown above (*vide supra*, p. 355) that *Callichrous gangeticus*, as recognised by Day, is a synonym of *Silurus cochinchinensis* Cuvier and Valenciennes.

Besides the two species referred to above there are five others recognised by Day, *viz.*, *C. bimaculatus*, *C. pabo*, *C. macrophthalmus*, *C. malabaricus* and *C. pabda*. Of these *C. pabo* can readily be distinguished from all others by its short maxillary barbels, not exceeding the length of head. In practice it has been very difficult to distinguish the other species precisely, especially when one has a large series of specimens for examination.

The first species that can be definitely assigned to this genus was described and figured by Bloch [4] as *Silurus bimaculatus* from Tranquebar. Among its characteristics he mentioned (i) projecting lower jaw, (ii) strong pectoral spine bearing teeth on its inner surface, (iii) anal fin long with 67 rays and (iv) tail fin yellow with voilet tips, upper surface of head and body voilet while the remaining parts are silvery.

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[1] Jordan, *Genera of Fishes*, pp. 65, 114 (1917).
[2] Day, *Fish. India*, p. 476, pl. cx, fig. 1 (1877).
[3] Deraniyagala, *Ceylon Journ. Sci.*, (B), XVI, p. 278 (1932).
[4] Bloch, *Ausländ. Fische*, VIII, p. 24, pl. ccclxiv (1794).

The figure shows the maxillary barbels extending considerably beyond the commencement of the anal fin.

Lacépède's[1] *Ompok siluroides* from Batavia, as emended by Cuvier and Valenciennes (*vide supra*, p. 257) is now definitely included in the synonymy of *Callichrous bimaculatus* (Bloch).

Hamilton[2] referred 5 species from " Bengal " to his genus *Callichrous* which he distinguished from one another as follows :

(i) *C. pabda*.—Pectoral spine smooth, anal with 54 rays, sides clouded with irregular black spots, longitudinal yellow stripe above lateral line, dark mark above pectorals, maxillary barbels extending beyond pectorals.

(ii) *C. canio*.—Pectoral spine smooth, anal with 69 rays, sides silvery, maxillary barbels " reach almost to the middle of the fish. " The main difference from *C. pabda* is that the sides are not clouded.

(iii) *C. duda*.—Pectoral spine smooth, anal with 73 rays, maxillary barbels " reach almost to the middle of the fish". This species " differs in nothing from the *canio* except in the number of rays in the fin behind the vent."

(iv) *C. chechra*.—Pectoral spine indented behind, anal with 67 rays, " cloud-like spots on the sides, but without the yellow stripe along the sides that the *pabda* has. On each pectoral fin is a large black spot." Maxillary barbels " reach to the end of the back fin."

(v) *C. pabo*.—Pectoral spine " much stronger than in the *Pabda*", the hind part being indented on the edge ; anal with 73 rays, colour silvery with green gloss above and purple gloss below ; maxillary barbels shorter than head.

Hamilton himself recognised the great similarity between all the species, especially among the first four. He also indicated in the case of *C. canio* that it had " a very strong resemblance to the *Silurus bimaculatus* of Bloch ", but the " tips of its tail fin are not black, a circumstance to which Bloch's fish owes its name. Besides, in Bloch's fish the first ray of each pectoral fin is a very strong indented prickle."

It is clear from the above that in differentiating species of this genus considerable reliance has been placed on colouration, nature of the pectoral spine, number of rays in the anal fin and the length of the maxillary barbels. As is well known, colouration in fishes varies considerably with the environmental conditions. Silvery specimens of a species may be found in clear waters, whereas in the specimens of the same species living in a pond over-grown with vegetation the sides are often clouded. The black tips of the caudal in Bloch's drawing of *S. bimaculatus* certainly represent a very exaggerated type. This fin is, in certain cases, edged with grey along the posterior margin. Day[3] noticed that " dark tipped caudal fins are not rare in Madras though uncommon inland." I have examined a young specimen 14 mm. long from Poona in which the tips of the caudal fin are greyish. The shoulder spot may be absent or present, when present it may be dumble-shaped but sometimes its anterior or posterior half is only clear. Day demonstrated that for *C. bimaculatus* and *C. pabda* no reliance can be placed on the number

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[1] Lacépède, *Hist. Nat. Poiss.*, V, p. 50, pl. i, fig. 2 (1803).
[2] Hamilton, *Fish. Ganges*, pp. 149-154 (1822).
[3] Day, *Fish. India*, p. 477 (1877).

of rays in the anal fin and on the nature of the pectoral spine to separate species of this genus. My examination of a large number of specimens in the collection of the Indian Museum has enabled me to confirm these views. The length of the maxillary barbels also varies considerably. I am of opinion that besides *C. pabo* there is only one other very variable species of this genus—*C. bimaculatus*—found in Indian waters, though its range extends as far east as Java, Sumatra and Borneo.

Cuvier and Valenciennes[1] described a number of new species in the genus *Silurus* from India which are now referred to *Callichrous*, *viz.*, *S. malabaricus*, *S. anastomus*, *S. mysoricus* and *S. microcephalus*. The description of the first species was based on small, badly preserved specimens collected from Malabar, the second species was described from Bengal and differenciated from *S. bimaculatus* by the fact that " a l'épine pectoral plus grêle, et quelques rayons de moins à l'anale." The species from Mysore was characterised as : " à tête plus plate et à corps plus elongé, plus comprimé que dans le *S. bimaculatus*, mais dont la caudale se partage de même en deux lobes pointus ". The last species was described from Bengal and with the exception that its head is contained 7 times in the length of the body, was stated to be closely allied to the form from Mysore. The descriptions of these species were based on insufficient material and without a proper understanding of the forms described by Hamilton. Moreover, the diagnostic characters are such that they fall within the range of individual variations. The four species of Cuvier and Valenciennes are, therefore, regarded by me as synonyms of Bloch's *S. bimaculatus*.

Silurus lamghur Heckel[2] from Kashmir is undoubtedly synonymous with *Callichrous bimaculatus*, the distinguishing characters given by its author have no specific value. In the figure the anal fin is shown just approaching the base of the caudal fin. Probably on this character Günther[3] assigned this species to the genus *Silurichthys*.

McClelland[4] described *S. indicus* from the Punjab and remarked : " This species is called Puftah at Loodianah, and is the same as the Puftah of Bengal, and identical with *Silurus canio*, *S. duda* and *S. chedra* (*sic*) of Buchanan, which would seem to be but varieties of a widely, diffused and common species." In the circumstances one fails to see why a new name was proposed by McClelland for the *Paftah* of the Punjab. The species is synonymous with *Callichrous bimaculatus* (Bloch).

In describing *Pseudosilurus macrophthalmus* from Tenasserim, Blyth[5] indicated its close resemblance to *C. pabda* Ham., but remarked that it is " proportionally less deep and more elongated, with eye of twice the diameter, and the lower jaw closing evenly with the upper, or very nearly so, though protruding when the mouth is open ; maxillary cirri much longer, reaching far beyond the more developed pectorals." Günther (*loc. cit.*, p. 45) included this species under *Callichrous* as a doubtful form, but Day[6] regarded it a valid species, with *Callichrous*

[1] Cuvier & Valenciennes, *Hist. Nat. Poiss.*, XIV, pp. 353, 363-365 (1839).
[2] Heckel, *Fische aus Caschmir*, p. 82, pl. xii, figs. 5 & 6 (1838).
[3] Günther, *Cat. Fish. Brit. Mus.*, V, p. 36 (1864).
[4] McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 583 (1842).
[5] Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 156 (1860).
[6] Day, *Fish. India*, p. 478 (1877).

notatus Day from Burma as its synonym. He remarked that *C. macrophthalmus* "is closely allied to *C. bimaculatus*, but has a larger eye, a narrow band of palatine teeth, much longer pectoral fins and maxillary barbels." He extended the range of the species to Madras and Assam and obsrved that "The only objection to uniting the Madras with the Assam and Burmese form is that the former has P. 1/12-13, the latter P. 1/15. The shoulder spot is not so well marked, and the dorsal fin not so developed in the Madras variety." Vinciguerra[1] had great difficulty in separating *C. macrophthalmus* from *C. bimaculatus* and from the Burmese specimens at his disposal he drew up a table of characters to differentiate the two species. Some of the characters noted for *C. macrophthalmus* are even contradictory to the original definition of the species. In determining specimens from Manipur, Assam, I[2] had the same difficulty. A study of the material in the collection of the Indian Museum has convinced me that Blyth's species cannot be regarded as distinct from the form described by Bloch.

Güther's[3] *C. ceylonensis* seems to differ from *C. bimaculatus* by the position of the blackish blotch above the pectoral which is "remote from the head" in the latter and "immediately behind the gill-opening" in the former. As remarked above this cannot be regarded as a character of sufficient value for separating the two species ; *C. ceylonensis* is, therefore, regarded as a synonym of *C. bimaculatus.*

Cryptopterus latovittatus Playfair[4] is, as pointed out by Day, a *Callichrous* in which the mandibular barbels appear to have been either overlooked or may have been absent.[5] Its description leaves no doubt that it is synonymous with *C. bimaculatus.*

Day has himself included his *C. egertonii*[6] in the synonymy of *C. pabda* which is regarded here as identical with *C. bimaculatus.*

Day described *C. nigrescens*[7] from Burma but later he[8] regarded it as a variety of *C. pabo* and remarked that "it was clouded all over with fine dark spots, and had black tips to the caudal lobes, and nine ventral rays." Prashad and Mukerji[9] also recorded coloured specimens of *C. pabo* from the Myitkyina District, but observed that in their specimens the pectoral spine is distinctly serrated internally. The two forms, no doubt, represent colour variations of the same species.

From the above analysis of the diagnostic characters of the various species of *Callichrous* described from India, it seems clear that only two valid forms can be recognised—*C. bimaculatus* (Bloch) with the maxillary barbels always considerably longer than the head and *C. pabo* Hamilton with the maxillary barbels always considerably shorter than the head. The latter species is rather rare and mainly confined to north-eastern India and Burma, while the former is very widely distributed in south-eastern Asia.

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[1] Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, (2), IX, pp. 201-205 (1890).
[2] Hora, *Rec. Ind. Mus.*, XXII, p. 178 (1921).
[3] Günther, *Cat. Fish. Brit. Mus.*, V, p. 46 (1864).
[4] Plyfair, *Proc. Zool. Soc. London*, p. 16 (1867).
[5] Day noted that in a young specimen of *C. nigrescens* "mandibular cirri were absent, but it was evidently the same species" (*Proc. Zool. Soc. London*, p. 617, 1869).
[6] Day, *Proc. Zool. Soc. London*, p. 710 (1871).
[7] Day, *Proc. Zool. Soc. London*, p. 616 (1869).
[8] Day, *Fish. India*, p. 478 (1877).
[9] Prashad and Mukerji, *Rec. Ind. Mus.*, XXXI, p. 177 (1929).

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INDIAN MUSEUM

Vol. XXXIX, Part IV, pp. 311–319

Systematic Position, Geographical Distribution and Evolution of the Cyprinoid genera with a Procumbent Predorsal Spine.

By

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CALCUTTA:
DECEMBER, 1937

SYSTEMATIC POSITION, GEOGRAPHICAL DISTRIBUTION AND EVOLUTION OF THE CYPRINOID GENERA WITH A PROCUMBENT PREDORSAL SPINE.

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The *Mystacoleucus*-group of Cyprinoid genera, comprising *Mystacoleucus* Günther[1], *Matsya* Day,[2] *Spinibarbus* Oshima[3] and *Spinibarbichthys* Oshima,[4] is characterised by the presence of a forwardly directed spine in front of the dorsal fin. *Mystacoleucus* is distinguished from the other three genera by its relatively long anal fin, containing 8-10 branched rays as against the usual number 5. *Matsya* (=*Acanthonotus* Day[5]) and *Spinibarbichthys* possess a serrated dorsal spine, whereas in *Spinibarbus* the dorsal spine is smooth. In elucidating the systematic position of these genera most of the workers do not appear to have paid attention to the generic characters of Day's *Matsya*. Smith,[6] who regarded it as congeneric with *Mystacoleucus*, gave no morphological details for his views. Unfortunately no specimen[7] of *Matsya argentea* Day is available for study either in the Indian Museum or in the Bureau of Fisheries Bangkok. Three specimens of *Mystacoleucus marginatus* (Cuv. & Val.) were sent to me in 1932 by Dr. H. M. Smith with the remark: "Are these *Matsya argentea* Day?" This observation indicates that Smith had confused either a colour variety of the common species *M. marginatus* with Day's form or he may have obtained specimens of the species—*M. chilopterus* recently described from Siam by Fowler[8]. It may further be noted that Suvatti in his "Index to Fishes of Siam" lists only one species of *Mystacoleucus*, *M. marginatus* (C. V.), which is recorded from Northern, Central and Peninsular Siam. Day's diagnosis of *Matsya* is, however, fairly complete and it leaves no doubt that *Spinibarbichthys* should be regarded as a synonym of *Matsya*. In most of the Cyprinoid genera the nature of the dorsal spine, whether serrated or entire, strong and bony or feeble and articulated, is not considered of sufficient importance for separating genera. I am, therefore, in agreement with Nichols and Pope,[9] Nichols[10], Myers,[11] Mukerji,[12]

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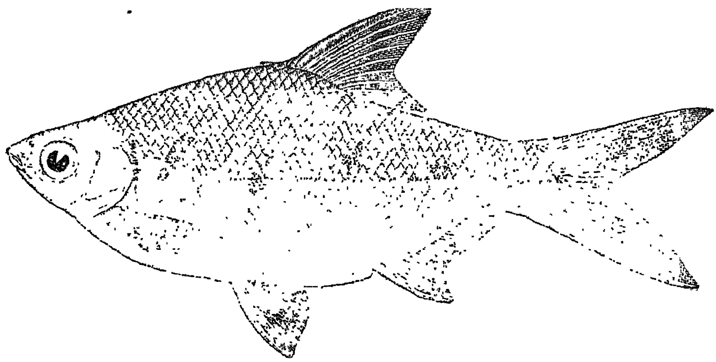
1 Günther, *Cat. Fish. Brit. Mus.*, VII, p. 206 (1868).
2 Day, *Faun. Brit. India*, Fish, I, p. 292 (1889).
3 Oshima, *Ann. Carnegie Mus.*, XII, p. 217 (1919).
4 Oshima, *Annot Zool. Japan*, XI, p. 10 (1926).
5 Day, *Fish. India*, (Suppl.), p. 807 (1888).
6 Smith, *Journ. Siam. Soc., Nat. Hist. Suppl.*, VIII, p. 185 (1931); *ibid.*, IX, p. 79 (1933).
7 Day's description of *Matsya argentea* was based on Tickell's manuscript description and figure of the species. Presumably Day did not examine any specimen of *M. argentea*.
8 Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVII, p. 112 (1935).
9 Nichols and Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, pp. 343, 344 (1927).
10 Nichols, *Bull. Amer. Mus. Nat. Hist.*, LVIII, pp. 11, 12 (1928).
11 Myers, *Lingnan Sci. Journ.*, X, pp. 258, 259 (1931).
12 Mukerji, *Rec. Ind. Mus.*, XXXIV, p. 284-286 (1932).

Mori[1] and Tchang[2] that *Spinibarbus* and *Spinibarbichthys* should be regarded as congeneric. Both these genera should, therefore, be assigned to the synonymy of *Matsya*. For the sake of convenience and on geographical grounds, it may, however, be desirable to treat *Spinibarbus* as a subgenus of *Matsya*.

In the four species of *Mystacoleucus*[3] known so far, *M. marginatus*, *M. padangensis*, *M. chilopterus* and *M. atridorsalis* Fowler,[4] the number of branched rays in the anal fin varies from 8 to 10 and I agree with Mukerji (*op. cit.*) that on this character alone they should be recognised as belonging to a distinct genus. It may here be noted that in a great majority of Cyprinoid genera there are only 5 branched rays in the anal fin. Any variation from this standard is, therefore, of special significance.



TEXT-FIG. 1.—Lateral view of *Mystacoleucus ogilbii* (Sykes). $\times \frac{3}{4}$.

Recently I collected two specimens of *Rohtee ogilbii* Sykes[5] (text-fig. 1) at Kurnool which possess a well-marked procumbent, predorsal spine. Other specimens of the same species in the collection of the Indian Museum were examined and a predorsal spine, sometimes hidden below the scales (text-fig. 2 *a*) was found in all of them. In this species the number of branched anal rays varies from 13 to 14, and the number of scales in the lateral line is about 55. Its pharyngeal bones and teeth are similar to those of *Mystacoleucus* (text-figs. 2 *b* & *d*), and its scales also show a close resemblance to those of *M. marginatus* (text-figs. 2 *c* & *e*). It seems reasonable, therefore, to include *Rohtee ogilbii* in the genus *Mystacoleucus*, the definition of which should be emended to comprise forms having 8-14 branched rays in the anal fin. In none of the other species of *Rohtee*, such as *R. bakeri* Day, *R. cotio* (Ham.), *R. duvaucelli* (Cub. & Val.), *R. vigorsii* Sykes, *R. belangeri* (Cuv. & Val.) and *R. feae* (Vinciguerra), I was able to detect any predorsal spine.

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[1] Mori, *Studies on the Geographical Distribution of Freshwater Fishes in Eastern Asia* (Chosen: 1936). In the various lists of Chinese fishes *Spinibarbus* is recognised as a valid genus, while *Spinibarbichthys* is considered a synonym of *Spinibarbus*.

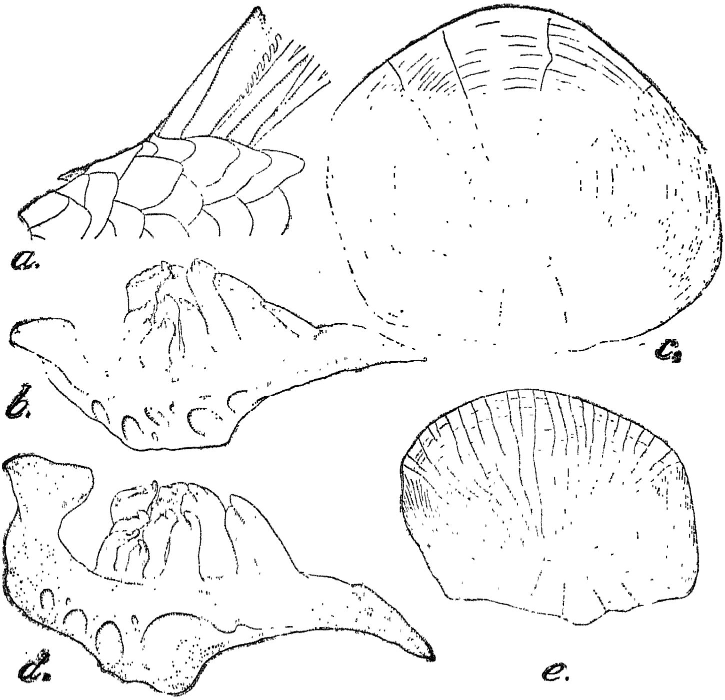
[2] Tchang, *Zoologia Sinica*, II, p. 43 (1936).

[3] For up-to-date descriptions of *Mystacoleucus marginatus* (Cuv. & Val.) and *M. padangensis* (Blkr.) see Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, III, pp. 108-110 (1916).

[4] Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXIX, p. 196 (1937).

[5] Sykes, *Trans. Zool. Soc. London*, p. 36 (1841).

The relationship of these species of *Rohtee* with Sykes' *R. ogilbii* is discussed later (*vide infra* p. 314).



Text-fig. 2.—*Mystacoleucus ogilbii* (Sykes) and *M. marginatus* (Cuv. & Val.).

a. Anterior portion of base of dorsal fin of *M. ogilbii*, showing the position of the procumbent, predorsal spine ×2½; *b.* Pharyngeal bone and teeth of *M. ogilbii.* ×7; *c.* Scale from below base of dorsal fin of *M. ogilbii.* ×25; *d.* Pharyngeal bone and teeth of *M. marginatus.* ×5; *e.* Scale from below base of dorsal fin of *M. marginatus.* ×5.

The question now arises which of the two genera is more primitive —*Matsya* or *Mystacoleucus*? In the case of the Cyprinoid genera it is well recognised that the short anal fin of 5 branched rays is a feature of specialisation, while in the primitive forms, such as *Opsariichthys*, *Chela*, *Barilius*, etc., the anal fin is fairly long. It would, therefore, seem probable on *a priori* grounds that *Mystacoleucus* represents a less specialised form than *Matsya*.

As indicated above the emended genus *Mystacoleucus*, especially the form *M. ogilbii*, shows great affinities with the members of the genus *Rohtee*, and it would be useful, therefore, to examine in the first place the precise limits of *Rohtee* and of its allied genera also.

In the species of *Rohtee* known from India and Burma[1], with the exception of *R. cunma* Day, the dorsal fin possesses a strong serrated spine and the number of branched anal rays varies from 11 in *R. bakeri* Day to 33 in *R. cotio* (Ham.). *R. cunma* was described by Day[2] from Moulmein and its dorsal fin is characterised by the possession of a " spine

[1] For description of most of the Indian and Burmese species of *Rohtee* see Day's *Fishes of India* and the " Fauna " volumes.

[2] Day, *Fish. India*, (Suppl.), p. 807 (1888).

weak and longer than the head, not serrated." Unfortunately no specimen[1] of this species is available for study. Vinciguerra[2], on the nature of the dorsal spine alone, doubted its inclusion in the genus *Rohtee*. Again Tchang's[3] separation of his *Parosteobrama* from *Osteobrama* Heckel[4] (=*Rohtee*) was also based on this feature. Fu and Wang[5] have, however, shown that Tchang's *Parosteobrama* is in reality *Parabramis* Bleeker and with this view Mori (*op. cit.*) agrees. Mukerji[6] doubted the advisability of separating *Parosteobrama* from *Rohtee* only on the nature of the dorsal spine. Thus, as in the case of *Matsya* (*vide supra*, p. 312), we have two groups of species in *Rohtee*, those with the dorsal spine serrated (*Rohtee* s. s.) and those with the dorsal spine smooth (*Parabramis*). In most of the species of *Rohtee* the abdominal edge is sharp and trenchant only behind the bases of the ventrals (*Rohtee* s. s.) whereas in *R. belangeri* (C. V.) the whole of the abdominal edge is sharp (*Smiliogaster* (Bleeker[7]). Similarly among Chinese fishes we have *Chanodichthys* Bleeker,[8] *Parabramis* Bleeker[9] and *Megalobrama* Dybowski[10] which are distinguished from one another by the nature of the abdominal edge. It is thus seen that *Rohtee* and the allied forms constitute a very generalised group showing considerable diversity in form and structure. Ignoring the nature of the abdominal edge and taking into consideration the nature of the dorsal spine, as in the case of *Matsya* and *Spinibarbus*, it may be useful to regard *Parabramis* as a subgenus of *Rohtee* on geographical grounds.

The geographical distribution of the genera *Matsya* and *Mystacoleucus* is very significant. *Matsya* of the *Spinibarbus*-type is known from Formosa [*M. hollandi* (Oshima) and *M. elongatus* (Oshima)], Fukien [*M. caldwelli* (Nichols)] and Hainan [*M. nigrodorsalis* (Oshima)]; while that of the *Spinibarbichthys*-type is found in Hainan [*M. denticulatus* (Oshima)], Szechwan [*M. pingi* (Tchang)] and Tenasserim [*M. argentea* Day]. The members of the two types meet in Hainan, but it may be noted that the forms found towards the west and the south are better armed than those found towards the east. *Mystacoleucus* is found in Siam [*M. marginatus* (Cuv. & Val.), *M. chilopterus* Fowler and *M. atridorsalis* Fowler], South Burma [*M. marginatus* (Cuv. & Val.)], Malay Peninsula [*M. marginatus* (Cuv. & Val.)], Sumatra [*M. marginatus* (Cuv. & Val.) and *M. padangensis* (Blkr.)], Java and Borneo [*M. marginatus* (Cuv. & Val.)] and the Deccan [*M. ogilbii* (Sykes)]. Here again in the more southern forms the dorsal spine is fully armed.

The geographical distribution of the fishes of the *Rohtee* and *Parabramis* groups is also interesting. Species of *Rohtee* are known from

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[1] As in the case of *Matsya argentea*, Day's description of this species is based on Tickell's manuscript description and figure. Presumably he had no specimen of *Rohtee cunma*.

[2] Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, (2), IX, p. 188 (1890).

[3] Tchang, *Bull. Soc. Zool. France*, LV, pp. 46-52 (1930).

[4] Hora, *Rec. Ind. Mus.*, XXII, pp. 187, 188 (1921), has already explained why *Rohtee* Sykes should have preference over *Osteobrama* Heckel.

[5] Fu and Wang, *Contrib. Biol. Lab. Sci. Soc. China*, VIII, *Zool. Ser.* No. 10 (1932).

[6] Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, pp. 69-71 (1934).

[7] Bleeker, *Nat. Tijdschr. Neder.-Indie*, XX, p. 428 (1859).

[8] Bleeker, *ibid*, p. 432 (1859).

[9] Bleeker, *Nederl. Tijdschr. Dierk.*, II, p. 21 (1865).

[10] Dybowski, *Verh. Zool-bo.t Gess. Wien.*, XII, p. 212 (1872).

Yunnan [*R. belangeri* (Cuv. & Val.), *R. cotio* (Ham.) and *R. microlepis* (Blyth)] and Burma and India (several species, mostly found in Peninsular India). Fishes of the *Parabramis*-type are found in the Amur System, North China, Kiao-Ho, Yangtse-Kiang, Hainan (several species) and Burma (only one species—*P. cunma*).

If the above distributional records are correlated with the extent of the anal fin, we notice that the forms possessing 5 branched rays in the anal fin (*Matsya*) are restricted to Southern China (Formosa, Fukien, Szechwan and Hainan) while one species (*M. argentea*) is also found in the interior of Tenasserim. The *Mystacoleucus*-type, with 8-14 branched rays, is restricted to Siam, Lower Burma, the Malay Archipelago and the Deccan. The *Rohtee*-type (long anal and serrated dorsal spine) is common in Peninsular India, other parts of India, Burma and Yunnan. The *Parabramis*-type (long anal and smooth dorsal spine) is common throughout China and only one species is found in Burma. As indicated above, in the Cyprinoid fishes a short anal fin of 5 branched rays is to be regarded as a feature of specialisation and it would, therefore, seem probable that *Rohtee* and *Parabramis* represent the ancestral forms of the entire group of fishes discussed above. Considering the present-day density of population of the various forms it seems probable that the centre of origin of these fishes was situated somewhere in South China. The diversity of form and specialisation, therefore, seems to have originated in this region and those species that spread towards north and north-west had probably to face less rigorous conditions of existence and did not, therefore, develop fierce, serrated dorsal spine; whereas those that spread towards south and south-west or remained in Southern China had to contend with more disturbed conditions due to the birth of the Himalayan chain of mountains and developed a strong, denticulated spine. *Rohtee cunma*, like *Matsya argentea*, is, however, an exception; it is found in Burma but corresponds to the forms that spread northwards. Its localised distribution signifies that it is a stray element of the northern-type that probably came to Burma with some later waves of migration.

As the ancestral stock travelled towards the south, the number of anal rays became fewer and fewer so that we get the *Mystacoleucus*-type in the Malay Archipelago on the one hand and in Peninsular India on the other. In the case of *Rohtee*, the species with the largest number of anal rays—*R. cotio*—is widely distributed from Southern China to Burma and India; while that with the smallest number of rays—*R. bakeri*—is found in the southernmost extremity of India. The greatest specialisation of all these forms, however, took place in Southern China, their ancestral home, where the fishes of the group possessing 5 anal branched rays, with the exception of *Matsya argentea*, are found today. It may here be noted that these fishes, with the exception of *Rohtee bakeri* Day, are not found south of the Cauvery watershed and neither have they spread to Ceylon or Africa. This point is discussed later (*vide* p. 318).

Many have regarded the predorsal spine as a character of great taxonomic importance, but Rendahl[1], who investigated its morphology,

[1] Rendahl, *Ark. Zool.*, XXIV A, No. 16, pp. 67-74 (1932).

considers it as a feature of convergence. By convergence we usually mean the presence of the same or a similar character in phylogenetically distantly related forms, and further it implies that the character is of special utility to the individuals concerned, for convergence is the result of adaptation of different organisms to a similar type of environmental conditions. In the case of the predorsal spine it is difficult to understand how it can be used as an organ of defence or offence. If, however, the morphology of the dorsal fin of all the forms referred to above is taken into consideration it may be possible to trace its probable mode of origin and to assign to it some definite function.

A very characteristic feature of *Rohtee* and *Parabramis* is that both the dorsal and the ventral surfaces are provided with sharp edges—especially the portion of the dorsal surface in front of the dorsal fin and that of the ventral surface behind the ventral fins. To support the sharp edge immediately in front of the dorsal fin the anterior portion of the first radial of the fin (text-fig. 3) is so modified that its distal edge trails close to the surface. In front of the radial elements there is a series of well-developed lamellar ossicles which lie between the neural spines of the adjacent vertebrae; these not only present a suitable surface for the attachment of muscles but also provide the necessary support for the keeled dorsal edge. Anteriorly these ossicles are replaced by the compressed neural spine of the compound vertebra and the supra-occipital crest. Bridge[1] described a similar series of bony elements in *Abramis brama* and *Tinca tinca* and concluded that "These ossicles are proximal segments of the fin supports of the atrophied anterior section of the dorsal fin." Whatever may be their phylogenetic significance, their presence is undoubtedly meant to provide a support to the sharp dorsal edge.

For the probable mode of origin of the pre-dorsal spine we may consider the structure of the dorsal fin of *Rohtee duvaucelli* (C. V.), *Mystacoleucus ogilbii* (Sykes) and *M. marginatus* (C. V.).

In *Rohtee duvaucelli* (text-fig. 3 *a*) the character of the radial skeletal elements of the dorsal fin is more or less similar to that of the four Cyprinoid types described by Bridge (*op. cit.*) except that its first radial element (*r. e.*) is better developed and its antero-dorsal border lies just below the sharp edge of the dorsal surface. It is preceded by a continuous series of lamellar ossicles (*l. o.*) which lie between the neural spines of the adjacent vertebrae. The median region of each ossicle is thickened to form a ridge-like structure. Near the bases of the neural spines, a further series of lamellar ossicles (*v. l. o.*) is developed from the anterior borders of the neural spines. Anteriorly they become more extensive and form broad supporting laminae between the neural spines. In *R. ogilbii* (text-fig. 3 *b*) the structures are similar to those of *R. duvaucelli* except that the first radial element (*r. e.*) is produced forward as a short spine, the lamellar ossicles are broad and thin. The ventral lamellar osicles near the bases of the neural spines have, more or less, coalesced with the spines, so that a forwardly directed outgrowth of the neural spine gives support to the neural spine of the vertebra anterior to it.

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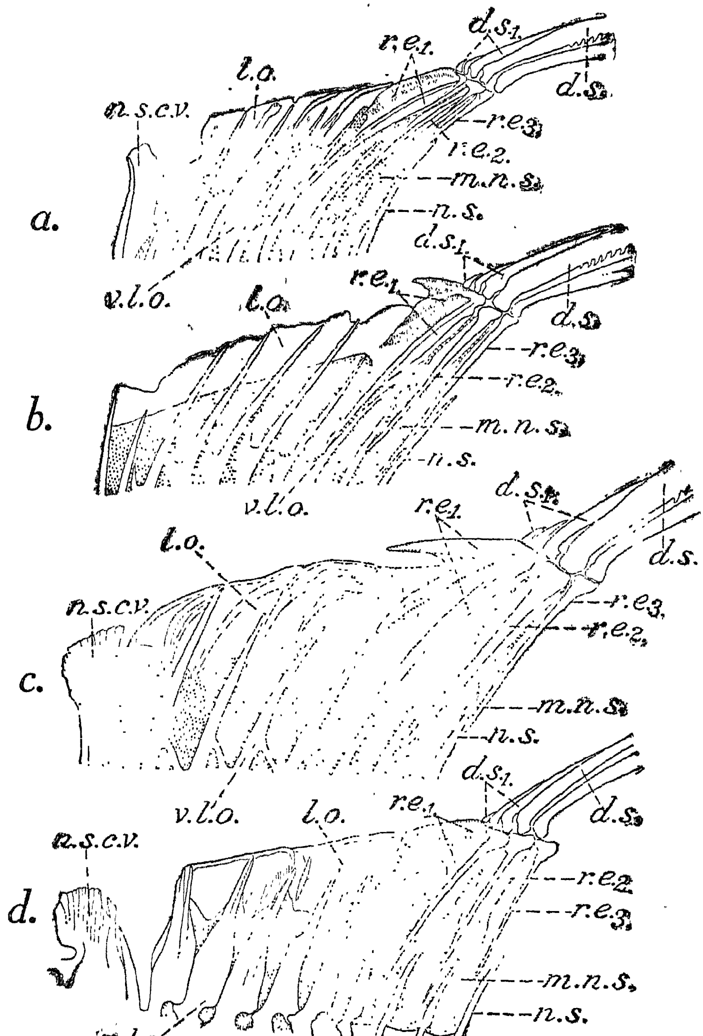
[1] Bridge, T. W.—The Mesial Fin of Ganoids and Teleosts. *Journ. Linn. Soc. London* (Zool.), XXV, p. 549 (1896).

In *R. marginatus* (text-fig. 3 *c*) the forwardly directed predorsal spine is considerably larger and the dorsal lamellar ossicles are provided with



TEXT-FIG. 3.—The skeletal elements of the dorsal spine and of the region in front of it in *Rohtee* Sykes, *Mystacoleucus* Günther and *Barbus* Cuvier.

a. Rohtee duvaucelli (Cuv. & Val.); *b. Mystacoleucus ogilbii* (Sykes); *c. M. marginatus* (Cuv. & Val.); *d. Barbus kolus* Sykes.

d. s.=Last dorsal spine; *d. s.*$_1$=Vestigeal dorsal spines; *l. o.*=Dorsal lamellar ossicles; *m. n. s.*=Membrane between neural spines; *n. s.*=Neural spine; *n. s. c. v.*=Neural spine of compound vertebra; *r. e.* 1. to *r. e.* 3.=Radial elements of the spines and the anterior fin rays; *v. l. o.*=Ventral lamellar ossicles.

strengthening ridges. The ventral lamellar ossicles are replaced by solid, bony columns between the adjacent vertebrae. Thus in the

three types described above we find that there are bony elements to strengthen the dorsal edge of the fish and that supports are developed to keep the neural spines in position and to prevent them from bending backwards. All these devices are probably meant to combat the stress imposed on the fish as it swims rapidly through water. Under such circumstances the utility of the predorsal spine would seem to present a stream-like wedge to the water before it approaches the dorsal fin. In the earlier stages of the flattening of the keeled dorsal surface it seems probable that more work was thrown on the predorsal spine. This assumption is borne out by the fact that the spine becomes larger and more powerful in the series of forms represented by *Mystacoleucus ogilbii*, *M. marginatus*, and *Matsya pingi*. (The spine of the last species was described and figured by Rendahl). When, however, the entire dorsal surface became stream-lined, the predorsal spine gradually disappeared. Such a course of evolution would indicate the production of "*Barbus*" from *Matsya*-like ancestors. If the presence or absence of a predorsal spine is ignored, *Barbus* and *Matsya* cannot be distinguished from each other by any other well-marked character. There would thus seem to be considerable justification for the views of Nichols and Pope[1] and Nichols[2] to regard *Spinibarbus* as a subgenus of *Barbus*. In *B. kolus* Sykes (text-fig. 3 *d*) the neural spine in front of the dorsal fin are laminated in their basal halves and the laminae in some cases overlap one another. The dorsal lamellar ossicles are also well-developed for the attachment of the muscles.

In connection with the above hypothesis, it has also to be considered that *Barbus* is a much more widely distributed genus than the fishes of the *Rohtee* or the *Matsya* groups; it is undoubtedly of great antiquity, as it is found as far afield as Africa. It is possible, therefore, that *Barbus* represents the earliest descendants of the original migrating stock, while *Rohtee*, *Mystacoleucus*, *Matsya*, etc., represent the later waves of migration of a somewhat modified stock which have not been able to reach very distant regions owing to the land connections having disappeared in the meantime.

SUMMARY.

Matsya Day, with 5 branched rays in the anal fin, is recognised as a valid genus and to its synonymy are assigned *Spinibarbus* Oshima and *Spinibarbichthys* Oshima. On geographical grounds, however, species with a serrated dorsal spine are referred to *Matsya* (s. s.) and those with a smooth spine to *Spinibarbus* (subgenus of *Matsya*).

Mystacoleucus Günther, with 8-10 branched rays in the anal fin, is recognised as a valid genus. Owing to the presence of a predorsal spine in *Rohtee ogilbii* Sykes, it is referred to *Mystacoleucus*, the definition of which is emended to include forms with 14 branched rays in the anal fin.

Mystacoleucus, with a longer anal fin, is regarded as more primitive than *Matsya*.

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[1] Nichols and Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, p. 343 (1927).

[2] Nichols, *ibid*, LVIII, p. 11 (1928).

The inter-relationships of *Rohtee* and *Parabramis* are discussed and the geographical distribution of all the forms referred to above is given. It is observed that the centre of distribution of these fishes has to be placed somewhere in South China whence at different periods different types of forms migrated both towards north and south. The northern forms retained their primitive features while, owing to the orogenic disturbances in South China and further south, the forms migrating towards south and those in the home-country became more highly specialised.

From a comparative study of the skeletal elements of the dorsal fin in 4 forms the probable mode of origin and function of the predorsal spine are given. It is concluded that *Barbus* was probably derived at a very early stage from *Matsya*-like ancestors.

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Vol. XXXVII, Part IV, pp. 459—461

A Note on the Systematic position of *Psilorhynchus aymonieri* Tirant from Cambodia.

By
SUNDER LAL HORA

CALCUTTA:
DECEMBER, 193

A NOTE ON THE SYSTEMATIC POSITION OF *PSILORHYNCHUS AYMONIERI* TIRANT FROM CAMBODIA.

By Sunder Lal Hora, *D.Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India.*

In 1883, Tirant[1] described a new species in the genus *Psilorhynchus* McClelland[2] from Cambodia and remarked : " Espèce nouvelle appartenant au groupe intéressant des Homaloptérinés, qui habitent les ruisseaux des montagnes boisées de l'Indo-Malaisie. On a dècrit deux espèces seulement du genre *Psilorhynchus* : les *P. sucatio*, et *P. balitora*, des torrents montagneux N.-E. du Bengale et de l'Assam." The description is accompanied by 4 outline drawings which are not only inaccurate but in several respects misleading. Two years later, Tirant[3] included the description of this species in his " Notes sur les Poissons de la Basse- Cochinchine et du Cambodge " and in referring to the genus *Psilorhynchus* remarked : " Les *Psilorhynchus* ont une apparence de Cyprin à forme peu ordinaire, en raison de leurs pectorales horizontale et de leur bouche de forme bizarre placée en dessous de la t.te. Ils habitent les riússeaux de montagnes." He included this genus in the family Homalopteridae which he characterised by the absence of an air-bladder. He distinguished *Homaloptera* from *Psilorhynchus* principally by the character of the barbels which are absent in the latter and present (6 in number) in the former. It seems probable, however, that in describing his new species of *Psilorhynchus* he did not study the character of the air-bladder for the unique specimen of *P. aymonieri* Tirant in the Lyon Museum is intact and there is no reference to the structure of the air-bladder in the description of the species. After Tirant no author seems to have referred to this species till Chevey[4] in 1934 published a " Révision synonymique de l' Oeuvre ichtyologique de G. Tirant " and regarded the species as having been correctly assigned to the genus *Psilorhynchus*.

The systematic position of the genus *Psilorhynchus* remained obscure for a long time and it is not surprising that earlier authors referred some of the flattened fishes of the mountain torrents of China and Siam without or with minute berbels to this genus. In another place I[5] defined the generic limits of *Psilorhynchus* after examining fresh material of Hamilton's[6] two species from India, and showed that they are sufficiently distinctive from other members of the Cyprinoidea to constitute a separate family of that order ; this view has been strengthened by the researches of Mukerji[7] on a much larger collection of these peculiar fishes. The

[1] Tirant, *Bull. Soc. Etudes Indochinoises Saigon* (1883) ; Chevey, *Notes de l'Institut Oceanographique de l'Indochine*, No. 6, pp. 35-37, pl. i (1929).

[2] McClelland, *As. Res.*, XIX, pp. 300, 428 (1839).

[3] Tirant, *Excursions et Reconnaissances*, IX (1885) ; Chevey, *loc. cit.*, p. 136 (1929).

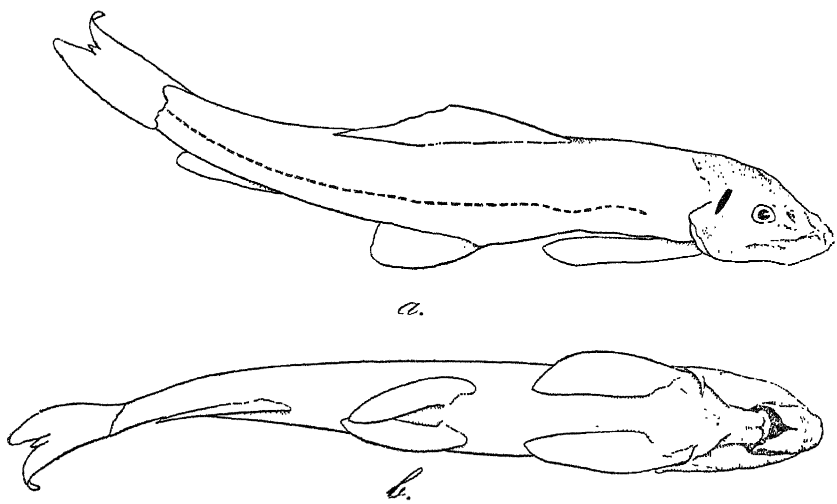
[4] Chevey, *loc. cit.*, No. 7, p. 43 (1934).

[5] Hora, *Rec. Ind. Mus.*, XXVII, p. 457 (1925).

[6] Hamilton, *Fish. Ganges*, pp. 347, 348 and 393 (Edinburgh : 1822).

[7] Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, pp. 823-828 (1933).

two Chinese species of *Psilorhynchus*, *P. sinensis* Sauvage & Dabry de Thiersant[1] and P. fasciatus Sauvage[2] were, on examination, found to belong to the Homalopterid genera *Hemimyzon* and *Pseudogastromyzon*[3] respectively. In view of the poor figures and inadequate description it was not possible, however, to evaluate the exact nature of Tirant's *Psilorhynchus* from Cambodia. In a description of the new species of *Psilorhynchus* from the Naga Hills, Assam, Mukerji and I[4] referred to *P. aymonieri* Tirant and remarked that "The descriptions and figures of the species recently reprinted by Chevey do not show its *Psilorhynchus* affinities, but it is difficult to assign any systematic position to it without examining the specimens". To clear up the distribution of this Indian genus, the Director of the Museum of Natural Sciences, Lyon, was requested for the loan of the type-specimen of Tirant's species. As the unique specimen could not be sent by post, Dr. Claude Gaillard, Director of the Museum, very kindly sent me photographs of the lateral and ventral views of the type-specimen. These photographs show very clearly that *P. aymonieri* must be referred to the genus *Gyrinocheilus* Vaillant[5]. I take this opportunity to publish fresh drawings of *P. aymonieri* which are prepared from the photographs supplied by Dr. Gaillard.



Gyrinocheilus aymonieri (Tirant) × $\frac{3}{5}$.
a : Lateral view of type-specimen ; *b* : Ventral view of same.

Only two species have so far been described in the genus *Gyrinocheilus*, one from Borneo—*G. pustulosus* Vaillant[6] and the other from Siam and Cambodia—*G. kaznakoi* Berg.[7] In describing the Siamese species,

[1] Sauvage & Dabry de Thiersant, *Ann. Sci. Natur. Paris*, (6) I, Art. 5, p. 14 (1874).
[2] Sauvage, *Bull. Soc. Philom. Paris*, (7) II, p. 88 (1878).
[3] Hora, *Mem. Ind. Mus.*, XII, pp. 299, 314 (1932).
[4] Hora & Mukerji, *Rec. Ind. Mus.*, XXXVII, p. 397 (1935).
[5] Vaillant, *Notes Leyden Mus.*, XXIV, p. 107 (1902).
[6] Weber & Beaufort, *Fish Indo-Austral. Archipel.*, III, pp. 224-225, figs.89, 90 (1916).
[7] Berg, *C. R. Trav. Soc. Nat. St. Petersb.*, XXXVII, pp. 305, 307 and 364-366 (1906).

Berg referred at length to the distinctive characters of the two species and later I[1] discussed the taxonomic importance of these characters and the systematic position of the genus *Gyrinocheilus*. Vaillant referred his genus to the Homalopterinae, but Boulenger[2] constituted a new sub-family Gyrinocheilini to accommodate it. Agreeing with Boulenger's view, I proposed the family Gyrinocheilidae for the genus.

G. aymonieri was found in a small stream called Prek-Tenot in the Samrong-Tong Mountains about 75 kilometres from Phnom-Penh, Cambodia. *G. kaznakoi* was described from the same river system; two specimens were obtained at Pai-lin between Battambang and Schantabun. I recorded the latter species from Nontaburi, while Smith[3] collected specimens " in the Menam Chao Phya at Nontaburi and Paknam; in Bung Borapet and Klongs draining that swamp, Central Siam; in mountain streams in the Pak Jong district, Central Siam; in the Menam Pong at Udon, Northeastern Siam; in mountain streams in Peninsular Siam east of Bandon; in the Menam Wang at Lampang, Northern Siam; and in the Meklong at Potaram and in the west branch of the Meklong north of Kanburi in Western Siam". From the wide distribution of *G. kaznakoi* and the occurrence of *G. aymonieri* in an adjacent locality, it seems to me certain that the two species are identical.

The structure of the snout in *G. aymonieri* is described by Tirant as follows :—" Un tubercule recouvert de pores à l'extrémité du museau; un autre tubercule médian sur le front, avec deux groupes de pores lateraux en triangle de chaque coté, deux autres tubercules latéraux très saillants un peu en arrière du front chacun d'eaux accompagné d'une ligne latérale de 9 pores." According to Berg, *G. kaznakoi* is distinguished from the Bornean species, among other characters, by the possession of a large central and two small lateral proboscides on the snout. I have compared the specimens of *G. kaznakoi* from Siam with the photographs and descriptions of *G. aymonieri* and am of opinion that the two species are identical.

In view of what is stated above *Gyrinocheilus kaznakoi* Berg 1906 has to be regarded as a synonym of *G. aymonieri* (Tirant) 1883.

In conclusion I have to offer my sincere thanks to Dr. Claude Gaillard, Directeur du Museum des Sciences Naturelles de Lyon, for his kindness in sending me photographs of the unique specimen of *Psilorhynchus aymonieri* Tirant.

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[1] Hora, *Journ. Nat. Hist. Soc. Siam*, VI, p. 159 (1923).
[2] Boulenger, *Cambridge Nat. Hist.*, VII, p. 582 (1909).
[3] Smith, *Journ. Siam Soc. Nat. Hist.*, Suppl., VIII, p. 187 (1931).

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Vol. XXXVII, Part I, pp. 49–67

Notes on Fishes in the Indian Museum. XXIV. Loaches of the Genus *Nemachilus* from Eastern Himalayas, with the description of a New Species from Burma and Siam.

By
SUNDER LAL HORA

CALCUTTA:
APRIL, 1935

NOTES ON FISHES IN THE INDIAN MUSEUM.

XXIV. Loaches of the genus *Nemachilus* from Eastern Himalayas, with the description of a New Species from Burma and Siam.

By Sunder Lal Hora, *D.Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.*

(Plate III)

The Nemachili of Eastern Himalayas are of special interest, as almost all the loaches (Cobitidae) described by Hamilton[1] in his "Gangetic Fishes" were obtained from the northern or north-eastern parts of Bengal. From the following table it is clear that the 12 species of loaches described by Hamilton were obtained during the period he carried out a survey of Bengal. In 1807, he surveyed the district of Dinajpur and from the commencement of the rainy season of 1808 till the advent of the cold weather, he was stationed at Goalpara. The first half of 1809 was spent in surveying Rangpur and during the cold weather of 1809-10 he was in the Purnea district. The rainy season of 1810 was spent at Nathpur near the Nepal frontier. All these districts are situated along the base of the Eastern Himalayas.

In the following table I give a list of the twelve species described by Hamilton with relative information as to their provenance and dates of descriptions of the different species in his "Original Notes."

"Gangetic Fishes."		"Original Notes."	
Scientific Name.	Locality.	Locality.	Date of description.
**Cobitis botia*, p. 350 .	North-eastern parts of Bengal.	Goalpara . .	1st July, 1808.
,, *gongota*, p. 351 .	Northern Bengal towards mountains.	Patgong . .	25th March, 1809.
,, *cucura*, p. 352 .	Kosi River . . .	Nathpur . .	4th August, 1810.
,, *guntea*, p. 353 .	Ponds and fresh rivers of Bengal.	Goalpara . .	?
,, *dario*, p. 354 .	Northern rivers of Bengal	Dumdumma .	29th October, 1807.
,, *pangia*, p. 355 .	North-eastern parts of Bengal.	Goalpara . .	30th July, 1808.
,, *geto*, p. 355 .	North-eastern parts of Bengal.	,, . .	14th August, 1808.
,, *balgara*, p. 356 .	Kosi River . . .	Nathpur . .	7th June, 1810.
* ,, *savona*, p. 357 .	,, ,, . . .	,, . .	14th July, 1810.
* ,, *turio*, p. 358 .	Brahmaputra River .	Goalpara . .	30th October, 1810.
* ,, *bilturio*, p. 359 .	,, ,, .	,, . .	8th November, 1808.
* ,, *corica*, p. 360 .	Kosi River . . .	Mainayi . .	29th March, 1810.

[1] Hamilton, *An Account of the Fishes in the River Ganges and its branches* (Edinburgh, 1822).

The drawings of the species discovered during the survey period were executed at Government expense and Hamilton was not allowed to take these drawings with him to Europe after his retirement. Most of the Cobitidae are, therefore, not figured in his monumental work, but his illustrations were reproduced later by McClelland[1] with full acknowledgment.

The five species marked with an asterisk(*) in the above table are without sharp, suborbital spines and are referrable to the genus *Nemachilus*. There has been considerable doubt about the precise specific limits of these species, but a study of the extensive material from round about the type localities has shown that *N. turio* and *N. bilturio* are synonymous with *N. botia*, the differences between them being due to sexual characters (*N. turio* and *N. bilturio* were described from female specimens, while *N. botia* represents male specimens), or to individual variation in colouration. *N. botia* is widely distributed in India and Burma. *N. savona* has been rediscovered and is described in detail; while for Day's *savona*, a new name *N. dayi* has been proposed. *N. corica* is already well known and deserves no further consideration in this place.

After Hamilton, McClelland described several new loaches, mostly from Assam, though there is reason to believe that his *Cobitis* (*Schistura*) *scaturigina* came from the Darjeeling Himalayas. Günther[2] added another *Nemachilus* to the fauna of the Eastern Himalayas by describing *N. beavani* from the Kosi River. Day[3] described *N. multifasciatus* from Darjeeling and Assam. The taxonomy of these three species is very confusing, but an attempt has been made in this paper to define their specific limits. Besides these old forms, two new species—*N. shebbearei* and *N. devdevi*—and a new variety—*N. rupecola* var. *inglisi*—have been found in collections from this area. Of the new species, *N. devdevi* is fairly common in the small streams below Darjeeling Himalayas, while *N. shebbearei* is represented by a single specimen from the Teesta Valley. The new variety, characterised by the presence of well-defined nasal barbels, is an eastern race of the commonest loach of the Western Himalayas.

The specimens described from Burma and Siam as *N. multifasciatus* Day are shown to be specifically distinct and the name *vinciguerrae* is proposed for them.

The nine species of *Nemachilus* from the Eastern Himalayas may be distinguished by the following key:—

A. About 14 branched rays in dorsal. (Body irregularly blotched; caudal fin entire or slightly emarginate) . *N. botia* (H. B.).

B. Not more than 8 branched rays in dorsal.

I. Body without vertical bands.

a. Body with one or two longitudinal series of spots *N. corica* (H. B.).

b. Dorsal surface and sides with a uniform dull grey colour *N. shebbearei*, sp. nov.

[1] McClelland, Ind. Cyp. *As. Res.* XIX, pp. 302-309 (1839).
[2] Günther, *Cat. Fish. Brit. Mus.* VII, p. 350 (1868).
[3] Day, *Fish. Ind.*, p. 617, pl. cliii, fig. 7 (1878).

II. Body with vertical bands.
- *a.* Lateral line incomplete.
  - 1. Caudal fin without bands; vertical bands few, broad and saddle-shaped, not extending to ventral surface . . . . *N. devdevi*, sp. nov.
  - 2. Caudal fin with four or more bands; body encircled by a number of bands . . . *N. multifasciatus* Day.
- *b.* Lateral line complete.
  - 1. Dorsal surface and sides dark with narrow, yellowish bands . . . . . . *N. savona* (H. B.).
  - 2. Dorsal surface and sides pale-olivaceous with dark, vertical bands separated by broad, yellowish interspaces.
    - α. Well-marked nasal barbels . . *N. rupecola* var. *inglisi*, nov.
    - β. Nasal flaps not produced into barbels.
      - i. Dorsal and caudal fins marked with numerous, irregular, narrow bands . *N. multifasciatus* Day.
      - ii. Dorsal with or without a row of spots; caudal with or without 1-3 V-shaped, fairly broad markings.
        - * Body with a few broad and bold bands encircling it; a broad, black band at base of caudal; ventrals extending to anal opening . . . *N. beavani* Günther.
        - ** Body with narrow, incomplete bands not extending to ventral surface; a narrow, black bar at base of caudal; ventrals not extending to anal opening . . . . . . *N. scaturigina* (McClell.).

In the above key *N. multifasciatus* is given in two places as it may have a complete or incomplete lateral line.

Though, in 1928, I had examined the material of *Nemachilus* in the collection of the British Museum, it was found necessary to refer to the old material again to determine the precise specific limits of the species described by Hamilton, McClelland, Günther and Day. Mr. J. R. Norman very kindly sent me a few duplicate specimens for examination and a sketch of the typical specimen of *N. beavani*. I am most grateful to him for his valuable assistance. The artists of the Zoological Survey of India and Babu R. Bagchi have executed the drawings with their usual skill and care and for this I am thankful to them. I have also to tender my thanks to Messrs. G. E. Shaw and E. O. Shebbeare who sent me an interesting collection of loaches from the Darjeeling Himalayas for study. Dr. B. Prashad has read through the paper and for this my thanks are due to him.

Nemachilus botia (Ham. Buch.).

1934. *Nemachilus botia*, Mukerji, *Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 39, pl. I, fig. 1; pl. iii, figs. 3 and 4.

Regarding the habitat of *Cobitis botia*, Hamilton[1] remarked that "The *Botia* is found in the rivers of the north-eastern parts of Bengal, and is nearly of the same size and qualities for eating as the *Loach.*' It was characterised as: "A *Cobitis* with a prickle under each eye; with six tendrils; with cloud-like marks on the sides; and with fourteen

[1] Hamilton, *Fish. Ganges*, p. 350 (1822).

rays in the dorsal, and eight in each ventral fin." The 'prickle' referred to above is the broad, cartilagenous process which is present in the males of several species of *Nemachilus* and is regarded as a secondary sexual character.[1] Female specimens of *N. botia* obtained at Goalpara were described by Hamilton as *Cobitis bilturio*, and, from the nature of colouration and general facies, it seems probable that his *C. turio* from Goalpara is also based on a somewhat abnormal female form of *Nemachilus botia*, the chief differences being that in *C. turio* the dorsal fin is shorter and the dorsal profile is more elevated. The collection before me contains several specimens of *N. botia* from the base of the Darjeeling Himalayas. Mukerji (*op. cit.*) has recently given a detailed description of this form. The species is very variable and is distributed all over northern India and Burma.

Nemachilus shebbearei, nov.

(Plate III, figs. 1 and 2.)

D. 2/8 ; A. 1/6 ; P. 10 ; V. 8 ; C. 18.

The remarkable loach, which I associate with the name of my friend Mr. E. O. Shebbeare, Conservator of Forests, Bengal, possesses a very characteristic facies. The body is low and the head is long and pointed. The dorsal profile is arched, while the ventral profile in front of the anal fin is straight and horizontal. The ventral surface is flattened and the paired fins are placed horizontally. The length of the head is contained 5 times in the total length and 4·1 times in the length without the caudal. The greatest width of the head is almost equal to its height at the occiput and is contained 1·8 times in its length. The eyes are prominent and are situated almost in the middle of the length of the head ; the diameter of the eye is contained 5 times in the length of the head, 2 times in the length of the snout and 1·6 times in the interorbital width. The eyes are dorso-lateral in position and are not visible from the ventral surface. The mouth is situated on the ventral surface slightly behind the tip of the snout ; it is small, semicircular and horizontal. The lips are fleshy and continuous at the angles of the mouth ; the lower lip is interrupted in the middle. The upper jaw overhangs the lower which is sharp and shovel-like. The barbels are subequal and are as long as the diameter of the eye. Below the anterior border of the eye is a bony process which is a characteristic feature of the males of several species of *Nemachilus*. The gill-openings are mostly restricted to the sides.

The body is depressed, while the tail region is compressed from side to side. The greatest depth of the body is contained 9 times in the total length and 7·4 times in the length without the caudal. The body is covered with small scales which are more conspicuous in the posterior region and are totally absent on the ventral surface in front of the anal opening. The lateral line is incomplete, terminating above the anal fin. The caudal peduncle is stout ; its least height is contained 1·4 times in its length.

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[1] Hora, *Rec. Ind. Mus.* XXIV, p. 81 (1922).

The dorsal fin is inserted in advance of the ventral and its commencement is slightly nearer to the tip of the snout than to the base of the caudal. It is long and has a concave margin; its longest ray is considerably greater than the depth of the body below it. The pectoral fin is shorter than the head and is separated from the ventral by a distance less than half of its length. The ventral fin is provided with a fleshy appendage; it does not extend to the anal opening which is situated almost midway between the tip of the ventral and the commencement of the anal fin. The caudal fin is shorter than the head and is emarginate with somewhat pointed lobes.

In the unique specimen of the species, the colouration is dull black on the dorsal surface and the sides. There are faint indications of colour bands in places. The ventral surface is pale-olivaceous. There is a large black blotch at the base of the caudal fin.

Type-specimen.—F $\frac{11720}{1}$, *Zoological Survey of India, Indian Museum, Calcutta.*

Locality.—Rivers of N. Bengal. (Messrs. G. E. Shaw and E. O. Shebbeare sent to the Indian Museum for identification a large collection of fish from the rivers and streams below Darjeeling. Though the majority of the specimens were properly labelled, some including the type of the species had no indication of any definite locality, but there can be no doubt that they were obtained from the Eastern Himalayas).

Remarks.—*Nemachilus shebbearei* is a *Homaloptera*-like species[1] with a greatly pointed snout and superficially resembles forms like *H. bilineata* Blyth and *H. modesta* (Vinciguerra). The presence of a single undivided ray in the paired fins and the characters of the mouth and its associated structures, however, show that it is a species of *Nemachilus*. From other species of the genus it can be readily distinguished by its characteristic facies and colouration.

Measurements in millimetres.

Total length including caudal	45·0
Length of caudal	8·0
Depth of body	5·0
Length of head	9·0
Width of head	5·0
Height of head at occiput	4·9
Length of snout	3·6
Diameter of eye	1·8
Interorbital width	3·0
Longest ray of dorsal	7·7
Longest ray of anal	4·2
Length of pectoral	8·5
Length of ventral	7·2
Length of caudal peduncle	3·8
Distance between tip of snout and commencement of dorsal	18·0
Distance between commencement of pectoral and that of ventral	10·2
Distance between tip of snout and anal opening	27·0

[1] Hora, *Mem. Ind. Mus.* XII, p. 274 (1932).

Nemachilus devdevi, sp. nov.

(Plate III, figs. 5 and 6.)

1878. *Nemachilus montanus*, Day (in part),[1] *Fish. India*, p. 616.
1889. *Nemachilus montanus*, Day (in part), *Faun. Brit. Ind. Fish.* I, p. 230.

D. 2/8 ; A. 2/5 ; P. 10 ; V. 6-8 ; C. 16.

Nemachilus devdevi is a small and slender species in which the dorsal profile is slightly arched and the ventral profile is almost straight and horizontal. The ventral surface in front of the anal opening is somewhat flattened, and the paired fins are placed horizontally. The head is narrow and broadly pointed; its length is contained from 4·1 to 5 times in the total length without the caudal. The width of the head is considerably greater than its height at the occiput and is equal to the length of the head behind the nostrils. The depth of the body is contained from 6 to 8 times in the length without the caudal. The head is proportionately smaller and the body more slender in larger specimens. The eyes are dorso-lateral in position and are not visible from the ventral surface; they are situated nearer to the tip of the snout than to the hinder border of the operculum. The diameter of the eye is contained from 3·6 to 4·2 times in the length of the head and from 1·2 to 1·6 times in the length of the snout. The interorbital width is almost equal to or slightly greater than the diameter of the eye. The eye is proportionately larger in smaller individuals. The nostrils are close to the anterior border of the eye and are separated by a cutaneous fold which terminates in a sharp point. The mouth is semicircular and horizontal, and is bordered by fleshy lips which are continuous at the angles; the lower lip is imperceptibly interrupted in the middle. The upper jaw is produced in the middle into a broad process; the lower jaw is sharp and shovel-like. The barbels are subequal and are longer than the diameter of the eye. The gill-openings do not extend very far below the bases of the pectoral fins.

In places the body seems to be covered with small indistinct scales; but the ventral surface is totally devoid of them. The lateral line is incomplete and terminates above the ventral fin. The caudal peduncle is long and muscular; its least height is contained from 1·7 to 2 times in its length.

The dorsal fin begins slightly in advance of the ventrals and its commencement is somewhat nearer to the base of the caudal than to the tip of the snout. The longest ray of the dorsal is greater than the depth of the body below it, but is shorter than the longest ray of the anal. The paired fins are similar in shape, being pointed in the middle; the pectoral fin is somewhat shorter than the head and extends for more than half the distance to the base of the ventral fin which just approaches the anal opening. The ventral fin possesses a well-developed appendage. The anal fin is separated from the base of the caudal by a considerable distance. The caudal fin is lunate, and is as long as the pectoral.

[1] Specimens from "Teesta" referred by Day to this species do not belong to it.

The colouration is very characteristic of the species. There are only a few, broad irregular bands on the body which are much wider than the interspaces between them. The bands extend from the dorsal surface to the sides, in some cases descending below the lateral line while in others they are restricted to the upper half of the body. The dorsal surface of the head is grayish and sometimes marked with short, irregular bars. The general colour of the body is pale-olivaceous while the ventral surface is much paler. The dorsal fin is marked with a series of two black marks across its rays and the proximal half of the caudal fin is invariably coloured gray. There is usually a deep black spot or short bar at the base of the caudal fin.

Type-specimen.—F $\frac{11752}{1}$, *Zoological Survey of India, Indian Museum, Calcutta.*

Locality.—Eastern Himalayas; small streams below Darjeeling and in Sikkim.

Remarks.—*Nemachilus devdevi* is readily distinguished by its slender body, characteristic colouration, incomplete lateral line and proportions. I have great pleasure in associating the name of this species with that of Mr. Dev Dev Mukerji of the Zoological Survey of India.

There are 10 specimens in the British Museum (Nos. 89. 2. 1. 1648-57) from " Teesta " presented by Day as *Nemachilus montanus* (McClelland), but they differ from the form described by Mc Clelland[1] from the Simla Hills. Though the specimens have lost much of their characteristic shape and colouration, they agree very closely with the new species described above. I examined these specimens in London in 1928 and, through the kindness of Mr. J. R. Norman, the authorities of the British Museum recently loaned me two of these specimens for detailed study.

Measurements in millimetres.

Total length including caudal	36·5	43·0	43·4
Length of caudal	6·1	7·3	7·3
Depth of body	5·1	4·7	4·6
Length of head	7·2	7·5	8·0
Width of head	5·0	5·2	5·5
Height of head at occiput	4·0	4·0	3·8
Length of snout	2·4	3·0	3·0
Diameter of eye	2·0	1·8	2·0
Interorbital width	2·1	2·2	2·2
Longest ray of dorsal	5·6	5·3	6·0
Longest ray of anal	6·0	6·0	6·3
Length of pectoral	6·1	7·0	7·8
Length of ventral	5·3	6·4	7·0
Length of caudal peduncle	5·3	7·2	7·0
Least height of caudal peduncle	3·1	3·6	4·0
Distance between commencement of pectoral and that of ventral	9·1	10·2	11·0

[1] McClelland, Ind. Cyprinidae, *As. Res.* XIX, pp. 307, 440, pl. lvii, fig. 1 (1838).

Nemachilus savona (Ham. Buch.).

(Plate III, figs. 3 and 4.)

1822. *Cobitis savona*, Hamilton, *Fish. Ganges*, p. 357.
1839. *Schistura savona*, McClelland, *As. Res.* (Ind. Cyprinidae) XIX, pp. 308, 442, pl. liii, fig. 3 (Reproduced from Buchanan's MS. drawing).
1839. *Acoura obscura*, Swainson, *Fishes* II, p. 310 (Name only).
1846. *Cobitis savona*, Cuvier & Valenciennes, *Hist. Nat. Poiss.* XVII, p. 32.
1854. *Cobitis savona*, Bleeker, *Verh. Bat. Gen.* XXV, p. 70 (Name only).
1868. *Nemachilus savona*, Günther, *Cat. Fish Brit. Mus.* VII, p. 354.

Nemachilus savona is a small loach which was discovered by Hamilton from the Kosi River.[1] The most striking feature of the species is its colouration—" Above the *colour* is dusky, with narrow yellowish bars; below it is white. The fin of the tail is dotted. The eyes are golden." The caudal fin, according to Hamilton, ends in a crescent. So far as I can judge from the literature, the species has never been discovered since Hamilton's time though the name has been used in a loose sense by several ichthyologists[2] for species of *Nemachilus* characterised by narrow bands. Recently, I have obtained abundant material from the base of the Darjeeling Himalayas which undoubtedly is referrable to *N. savona*, and I take this opportunity to redescribe it with figures as the existing descriptions are inadequate.

Among the 144 drawings of fish[3] left behind in India by Hamilton at the time of his departure in 1815, there is a beautiful delineation of *N. savona* (No. 54, labelled *Cobitis Savon Khurika*). It was reproduced by McClelland in his Indian Cyprinidae, and served as the basis of the remarks by Cuvier & Valenciennes and Günther. Günther was so impressed with the colouration of the species that he kept it apart in a section by itself which he characterised as: " Body with narrow yellow transverse bars." The figure shows that there is a row of black dots along the middle of the rays of the dorsal fin. Confusion regarding the identity of this species seems to have been started by Day who referred to it specimens obtained " from the hills near Raniganj " and from " N. W. Provinces." A specimen from the latter locality is figured in his *Fishes of India* (pl. clv, fig. 8). A comparison of Day's figure and description of *savona* with Hamilton's figure and description of *savona* brings out the following differences in colouration :—

Day's *savona*.	Hamilton's *savona*.
1. Ground colour of the dorsal surface of the body is ' purplish.'	Ground colour of the dorsal surface of the body is ' dusky .'
2. Dorsal fin is marked with 4-5 rows of spots and the base marked with blotches.	Dorsal fin is marked with a single row of spots, and the base is devoid of any markings.
3. Caudal fin is marked with several irregular bands.	Caudal fin is marked with three indistinct rows of spots.
4. The number of yellowish narrow bands is 14.	The number of yellowish narrow bands is 9.
5. Ventral and anal fins are banded .	Ventral and anal fins are devoid of markings.

[1] According to Buchanan's ' Original Notes ' concerning *Gangetic Fishes*, *Cobitis savona* was obtained in the Kosi River at Nathpur. In my account of *Amblyceps mangois* (*Rec. Ind. Mus.* XXXV, p. 612, 1933), I referred to this locality and indicated that the ecological conditions prevailing there may have been similar to those now found in the small streams at the base of the Eastern Himalayas.

[2] Beavan, *Freshwater Fish India*, p. 109 (1877); Day, *Fish India*, p. 619, pl. clv, fig. 8 (1878); *Faun. Brit. India, Fishes*, I, p. 234 (1889); Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 211 (1890); Jenkins, *Rec. Ind. Mus.* V, p. 128 (1910); Annandale, *Rec. Ind. Mus.* XVI, pp. 125, 127 (1919).

[3] Hora, *Mem. Ind. Mus.* IX, p. 173 (1929).

It is clear from the above that, so far as the colouration is concerned, the two forms are not conspecific. I have examined large numbers of fresh specimens of both kinds and am of opinion that Day's *savona* represents a new species which may be designated **Nemachilus dayi.**[1] *N. savona* (Ham. Buch.) may be redescribed as follows :—

D. 3/8 ; P. 9 ; V. 7 ; A. 2/5 ; C. 20.

Nemachilus savona is a small and slender species in which the body is pointed at both ends. The dorsal profile is slightly and gracefully arched, while the ventral profile is almost horizontal and straight throughout. The ventral surface is flattened, but the fish appears to be subcylindrical. The head is narrow and pointed ; its length is contained 5·5-5·8 times in the total length and 4·7 times in the length without the caudal. The width of the head is contained 1·5-1·6 times and the height at occiput 1·9-2·0 times in its length. The eyes are prominent, dorsolateral in position and not visible from the ventral surface ; they are situated almost wholly in the anterior half of the head. The diameter of the eye is contained 3-3·5 times in the length of the head, 1·5-1·7 times in the length of the snout and 1·6-1·8 times in the interorbital width. The interorbital space is flat or slightly convex. The mouth is inferior, transverse and semicircular ; it is bordered by fleshy lips which are fimbriated. The lips are continuous at the angles of the mouth, but the lower lip is interrupted in the middle and ends on both sides in fleshy, prominent areas. The upper jaw is produced in a beak-like process in the middle which projects in front of the lower jaw. The lower jaw has a plain sharp edge which is not notched. The three pairs of barbels are short and stumpy ; the outer rostral and the maxillary pairs are longer than the eye while the inner rostrals are as long as the eye.

The depth of the body varies considerably ; it is contained 7·1-11 times in the total length and 6-9 times in the length without the caudal. The body is covered with small, but well defined, scales which are more prominent in the posterior region. The ventral surface is smooth and devoid of scales. The lateral line is complete and runs in a groove along the middle of the body. The caudal peduncle is rather long ; its least height is contained 1·9-2 times in its length.

The dorsal fin is inserted in advance of the ventral and its commencement is invariably nearer to the tip of the snout than to the base of the caudal, but in some specimens it is equidistant. The longest ray of the dorsal fin is longer than the depth of the body below it. The outer edge of the fin is obliquely truncate. The paired fins are fan-like, horizontal and broadly pointed in the middle. The pectorals do not extend to the ventrals which are separated from the anal opening by a considerable distance. The anal fin, when laid flat, does not reach the base of the caudal which is emarginate and possesses rounded lobes.

A reference to the characteristic colouration of the species has already been made. In the large number of specimens before me, the dorsal and lateral surfaces of the head and body are dark-brown, the head being

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[1] Specimens Nos. 89.2.1.1697-9 of the British Museum collection belong to this species They were collected by Day from the " N. W. Province." Both dorsal and caudal fins are spotted with numerous, irregular, dark spots.

darker than the body; while the ventral surface in front of the anal fin is pale-olivaceous, behind the anal it is marked with the bands descending from the sides. The body is marked with 9-10 narrow, yellowish bands which almost encircle the fish. Of these bands, there are 4[1] in front of the dorsal fin, 2 or 3 below it and 3 or 4 behind it. There is a vertical black mark at the base of the caudal fin which is of a somewhat grayish colour. The fins are usually devoid of any markings but in some specimens the caudal fin is provided with one or two V-shaped bands and the rays of the dorsal and anal fins are marked with black dots in the middle. The ventral surface of the head is irrorated with black dots which are also present along the edges of the ventral surface.

Distribution.—Hamilton collected specimens of *Nemachilus savona* in the Kosi River at Nathpur which used to be situated in the extreme north-east of the district of Bhagalpur (as delimited at present) and close to the boundary of Purnea. Large series of specimens have recently been collected from the foot of the Darjeeling Himalayas at Sevoke and Siliguri. It seems probable that this species has a wide range in the small, rapid and clear streams of the eastern sub-Himalayan region.

Measurements in millimetres.

Total length including caudal	33·0	32·0	32·0	31·0
Length of caudal	5·0	5·6	4·8	5·8
Depth of body	4·6	4·3	3·9	2·8
Length of head	6·0	5·6	5·6	5·3
Width of head	4·0	3·6	3·6	3·2
Height of head at occiput	3·0	2·9	2·7	2·6
Length of snout	2·0	1·7	1·7	1·5
Diameter of eye	1·2	1·0	1·0	1·0
Interorbital width	2·0	1·8	1·8	1·6
Longest ray of dorsal	5·0	5·0	5·0	5·0
Longest ray of anal	3·8	4·3	3·6	4·0
Length of pectoral	6·0	5·3	5·6	6·0
Length of ventral	5·4	4·2	4·8	4·6
Length of caudal peduncle	5·0	4·0	4·6	4·6
Least height of caudal peduncle	2·5	2·2	2·2	2·2
Distance between tip of snout and commencement of dorsal	12·6	13·1	12·6	12·0
Distance between commencement of pectoral and that of ventral	8·0	7·5	7·5	7·0

Nemachilus rupecola var. **inglisi,** nov.

(Plate III, figs. 9 and 10.)

1869: *Nemachilus rupecola,* Günther, *Cat. Fish. Brit. Mus.* VII, p. 351.

" *Schistura rupecula* " was described by McClelland[2] from " Mountain streams at Simla," and since then the species has been found to be widely

[1] In Hamilton's MS drawing the first band, which is situated immediately behind the head, is not shown but 9 bands in all are figured (3 predorsal, 2 subdorsal, 4 post-dorsal).

[2] McClelland, *Journ. As. Soc. Bengal,* VII, p. 948, pl. lv, fig. 3 (1838); Ind. Cyprinidae, *As. Res.,* p. 309, pl. lvii, fig. 3 (1839).

distributed in the Western Himalayas. In the Eastern Himalayas, it is replaced by a form which, though very similar, is readily distinguished by certain well-marked characters.

Günther described *N. rupecola* from 5 specimens obtained in Sikkim, and an examination of these examples has shown that they are identical with hundreds of specimens collected at different places below Darjeeling. The most conspicuous feature of this form is, as has already been noticed by Günther, that the barbels are well developed and that there is a distinct nasal appendage. The last character has been considered of great taxonomic value by certain authors[1] in subdividing the vast assemblage of species grouped under the generic name *Nemachilus*, but I[2] have shown elsewhere that there are a number of species showing all possible gradations between the total absence and the presence of a distinct nasal barbel. Though this character is useful in distinguishing species within the genus, it cannot be used for separating closely allied forms into different genera.

In the typical *rupecola* of the Western Himalayas the nasal appendage is present, but is not so well marked and it seems desirable to separate the Darjeeling form into a distinct variety which I have the pleasure of associating with the name of Mr. C. M. Inglis, Curator of the Natural History Museum at Darjeeling. The new variety may be described as follows :—

D. 2/7 ; A. 1/5 ; P. 12 ; V. 8 ; C. 16.

Nemachilus rupecola inglisi is an elongated, stout muscular fish in which the dorsal profile is slightly arched, and the ventral profile is straight and horizontal throughout. The ventral surface in front of the anal opening is flattened and the paired fins are horizontally placed. The head is short and broad, being only slightly longer than broad. The length of the head is contained 4·5-5·1 times in the length without the caudal and the height of the body 5·2-7·1 times in the same dimensions. The eyes are dorso-lateral in position, are situated almost in the middle of the head and are not visible from the ventral surface. The nostrils are situated near the superior margin of the eye and are separated by a flap bearing a well developed barbel. The mouth is semicircular and horizontal ; it is situated slightly behind the tip of the snout. The lips are fleshy and are continuous at the angles of the mouth ; the lower lip is interrupted in the middle. The upper jaw is produced into a beak-like process in the middle, while the lower jaw is notched in the corresponding position. All the barbels are longer than the diameter of the eye ; the inner rostrals are shorter than the other two pairs. The gill-openings are mostly restricted to the sides.

The body is covered with small, indistinct scales which are embedded in the skin. The lateral line is complete. The ventral surface appears to be totally devoid of scales. The caudal peduncle is deep and stout ; its least height is contained 1·1–1·3 times in its length.

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[1] Jordan and Fowler, *Proc. U. S. Nat. Mus.* XXVI, p. 768 (1903) ; Weber and Beaufort, *Fish Indo-Austral. Archipel.* III, p. 35 (1916).

[2] Hora, *Rec. Ind. Mus.* XXXI, p. 312 (1929).

The dorsal fin is inserted opposite the ventrals, and its commencement is nearer to the base of the caudal than to the tip of the snout. The longest ray of the dorsal is shorter than the depth of the body. The anterior margin of the fin is rounded. The pectoral fin is shorter than the head, and is separated from the ventral by a considerable distance. The ventral fins which are similar to the pectorals, are broad and rounded, and do not extend as far as the anal-opening, which is situated at a distance equal to the diameter of the eye from the commencement of the anal fin. The anal fin is separated from the caudal by a considerable distance. The caudal fin is almost as long as or somewhat shorter than the head; it is either truncate or slightly bilobate with the lobes rounded.

The body is marked with 14 to 16 vertical bands which are broader than the interspaces between them. A black spot is usually present at the base of the anterior dorsal rays, and generally there are short, dark streaks on the outer rays of the dorsal and caudal fins. The arrangement and the number of colour bands varies considerably and in some young examples they are absent altogether. The dorsal surface of the head is marked with closely set black spots.

Type-specimen.—F $\frac{11755}{1}$, *Zoological Survey of India, Indian Museum, Calcutta.*

Locality.—Eastern Himalayas, rivers below Darjeeling and in Sikkim.

Remarks.—The variety *inglisi* differs from the typical *rupecola* in the possession of a distinct nasal barbel, relatively smaller fins and in its stouter built. The position, form and structure of its paired fins indicate that this variety is better adapted for life in rapid currents than the typical form. The outer rays of the paired fins are provided with adhesive pads on the ventral surface.

Measurements in millimetres.

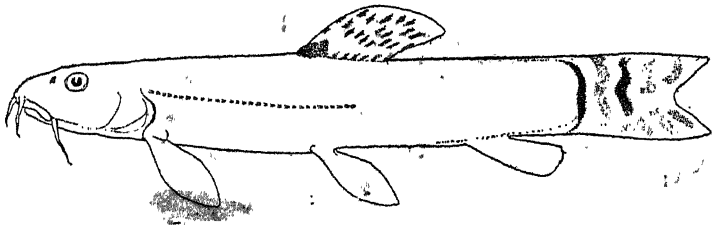
Total length including caudal	68·5	58·0	66·5	83·5	80·2	93·3	88·5	70·0
Length of caudal . . .	9·3	10·0	9·2	13·8	11·8	13·0	12·1	10·5
Length of head	12·3	10·5	11·3	13·6	13·2	15·8	15·8	12·3
Greatest depth of body . .	10·0	8·0	11·0	11·2	10·2	11·2	11·5	9·0
Length of snout . . .	5·8	4·5	5·0	6·2	6·5	7·8	7·2	5·6
Interorbital distance . . .	5·4	4·2	5·0	6·0	5·8	6·3	6·2	4·5
Length of caudal peduncle . .	9·2	7·3	8·2	10·2	9·5	12·3	10·0	7·7
Least height of caudal peduncle .	8·2	6·0	7·2	9·2	8·7	8·4	9·0	7·0
Longest ray of dorsal . .	8·5	7·5	9·0	10·5	9·8	10·8	10·8	8·2
Length of pectoral . . .	11·0	10·0	11·2	14·3	13·0	14·0	13·8	11·0
Length of ventral . . .	10·2	9·2	10·3	13·8	12·4	13·0	12·4	9·8
Longest ray of anal . . .	7·0	7·2	7·3	9·8	9·0	10·5	10·8	8·2
Distance between tip of snout and commencement of dorsal.	32·0	26·2	30·2	36·3	36·0	41·6	41·0	32·0
Distance between commencement of pectoral and that of ventral.	20·0	16·5	19·8	21·0	21·3	25·0	24·0	18·5
Distance between tip of snout and anal opening.	44·0	36·8	43·0	50·6	49·8	57·0	56·2	42·4

Nemachilus multifasciatus Day.

1878. *Nemachilus multifasciatus*, Day, *Fish. Ind.*, p. 617, pl. cliii, fig. 7.
1889. *Nemachilus multifasciatus*, Day, *Faun. Brit. Ind. Fish.* I, p. 231.

Nemachilus multifasciatus, which was described by Day from "Darjeeling and Assam", has never been collected again from these places. The Burmese and Siamese specimens reported under this name[1] are not conspecific with the Indian species and I propose for these the name *Nemachilus vinciguerrae*, sp. nov. (*vide* p. 62).

With the original description, Day figured a specimen from Darjeeling which is preserved in the collection of the Zoological Survey of India, but is unfortunately not in a fit condition for taxonomic purposes. Mr. J. R. Norman has sent me for study Day's specimen of the species from Assam (No. 89.2.1.1669), and it is now clear that the species has to be regarded as valid, it is distinguished by the colour-markings on the dorsal and caudal fins. Day, describes the colouration as follows; "vertical bands as wide as the ground-colour, pass from the back to the lower surface of the abdomen, those between the head and the dorsal fin are numerous, while there are about five posterior to it. In some examples these anterior bands coalesce. A dark band at the base of the caudal and dark marks on the head radiating from the eye. *Fins yellow, the dorsal with four bands of spots and an equal number or more on the caudal. Ventrals and anal with two bands each*" (Italics are mine). Hitherto, more attention has been paid to the markings of the body, but I have indicated that in two other Eastern Himalayan species—*N. beavani*



TEXT-FIG. 1.—Lateral view of a typical specimen of *Nemachilus multifasciatus* Day from Assam, showing the colour pattern on the dorsal and caudal fins. ×1⅗. (Brit. Mus. No. 89.2.1.1669).

and *N. scaturigina*—the bands in front of the dorsal break up resulting in numerous bands as described by Day for his *multifasciatus*. This feature is also characteristic of *N. vinciguerrae*. The chief distinguishing feature of *N. multifasciatus* lies in the fact that the dorsal and caudal fins are provided with many rows of spots which are sometimes irregularly distributed. The only other species, which shows this character, is Day's *savona* for which I have proposed the name *dayi* (*vide* p. 57). The two species can be readily distinguished by the colouration of the body—narrow, yellowish inter-spaces between bands in *dayi* and wide, pale interspaces between bands in *multifasciatus*.

[1] Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 209 (1890); Mukerji, *Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 43 (1934); Hora and Mukerji, *Rec. Ind. Mus.* XXXVI, p. 135 (1934).

Day included McClelland's *subfusca* with a query in the synonymy of his *multifasciatus*, but assigned Günther's *montanus*[1] (*nec* McClelland) definitely to its synonymy. I have discussed the specific identity of *subfusca* in another place (*vide* p. 65) and shown that it is synonymous with *N. scaturigina*. In Günther's *N. montanus* the dorsal and caudal fins are provided with a single row of spots, so it is not conspecific with *multifasciatus*. I have examined the two specimens of Günther's *montanus* in the British Museum and am of opinion that they do not belong to McClelland's *montanus* from the Simla Hills.

In the Assamese specimen of *N. multifasciatus*, the ventrals do not reach the anal opening; the lateral line is incomplete,[2] extending only as far as the commencement of the ventral; scales are minute but fairly distinct; the upper jaw is produced into a prominent beak in the middle and the lower jaw is emarginate to receive this prominence. As the specimen is flabby, no reliance can be placed on the measurements of its various parts. The colouration of the body is faded, but the rows of spots on the dorsal and caudal fins are fairly distinct.

Nemachilus vinciguerrae, sp. nov.

(Plate III, fig. 12.)

1890. *Nemachilus multifasciatus*, Vinciguerra (*nec* Day), *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 209.
1834. *Nemachilus multifasciatus*, Mukerji (*nec* Day), *Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 43.
1934. *Nemachilus multifasciatus*, Hora & Mukerji (*nec* Day), *Rec. Ind. Mus.* XXXVI, p. 135.

In my[3] revision of the fishes of the genus *Nemachilus* from Burma, it was indicated that Vinciguerra's *N. multifasciatus* may be a new species, but as the precise specific characters of Day's *N. multifasciatus* were not known, it was decided not to deal with the species. Recently, Mukerji described Burmese and Siamese material which he referred to *multifasciatus* (*sensu lato*). Mukerji and I identified a specimen from the S. Shan States as *N. multifasciatus* as recognised by Vinciguerra. Having now examined a tolerably good specimen of Day's *multifasciatus*, I am in a position to refer the Burmese and Siamese specimens to a distinct species for which I propose the name *N. vinciguerrae*. A full description of this species has already been published by Mukerji, and only a few necessary notes are added here to supplement his account. The body is marked with a number of vertical bands which, in some specimens, break up anteriorly. The dorsal surface and sides of the head are covered with short, black markings. In the middle of the base of the caudal fin, there is a well-marked, short, prominent, vertical band. The dorsal fin has one, sometimes two, series of spots; the caudal fin has two V-shaped bands and the ventral and anal fins with one band each. The body is slender. The lateral line is complete. The scales are better developed than in *N. multifasciatus*. The beak of the upper jaw is not so prominent as in *N. multifasciatus*.

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[1] Günther, *Cat. Fish Brit. Mus.* VII, p. 350 (1868).
[2] According to Day, the lateral line is complete in *N. multifasciatus*.
[3] Hora, *Rec. Ind. Mus.* XXXI, p. 314 (1929).

Type-specimen.—F. $\frac{11754}{1}$, *Zoological Survey of India, Indian Museum, Calcutta.*

Nemachilus beavani Günther.

(Plate III, fig. 11.)

1868. *Nemachilus beavani*, Günther, *Cat. Fish Brit. Mus.* VII, p. 350.
1877. *Nemachilus beavani*, Beavan, *Freshwater Fish India*, p. 107.
1924. *Nemachilus* sp., Hora, *Rec. Ind. Mus.*, p. 28, fig. 1.

The species was described from a single specimen, two inches long, collected by Lieut. R. C. Beavan from the " Kossye River," but no figure of it has so far been published. Day[1] referred specimens from the Bhavani River to this species and regarded his *Nemachilus chryseus*[2] as a synonym of *N. beavani*, which, according to him, is found in " Bowany in Madras and Mysore, also Orissa." Day's *N. beavani* is probably conspecific with *N. denisonii* Day, a very variable species as regards its colouration, but I have no doubt, that it is not the same as Günther's *beavani*.

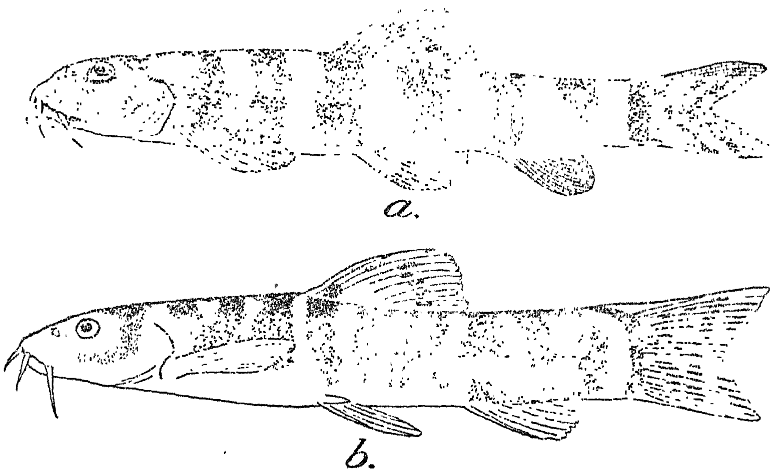
Recently, Fowler[3] assigned a large series of specimens from the head-waters of the Sutlej and Beas Rivers to *N. beavani* and gave a short description of his specimens. Unfortunately he has made no observations on colouration. According to him, the species is characterised " by its broad or depressed head and well-developed rudimentary caudal rays." In the collection of the Zoological Survey of India, there are half a dozen specimens received in exchange from the Academy of Natural Sciences, Philadelphia, and determined by Dr. H. W. Fowler as *N. beavani*. The colour is faded. From their general facies and form of the caudal fin, they can be readily distinguished from Günther's *beavani* in which the head is not so depressed and the snout is obtusely pointed. I shall discuss the identity of Fowler's *beavani* in my account of the Nemachili from the Western Himalayas.

In 1924, I described specimens of *Nemachilus* from the Garo Hills in Assam, but was unable to assign them to any species. Recently a large number of similar specimens have been collected in the small streams below Darjeeling and while identifying them, it was found necessary to investigate the precise specific limits of *N. beavani*. The matter was referred to Mr. J. R. Norman of the British Museum who sent me a sketch of the type-specimen of Günther's species. The drawing, which is reproduced here, leaves no doubt that my Garo Hills and Darjeeling specimens have to be referred to *N. beavani*. As a fairly complete description of the species has already been published (Hora, 1926) a few notes are given here regarding variation in its colouration.

The characteristic feature of the species is that the vertical bands are broad and fewer in number. The dark band at the base of the caudal fin is broad and conspicuous, though in the type-specimen it is somewhat narrower. In certain specimens the bands, especially those

[1] Day, *Fish. India*, p. 620, pl. clvi, fig. 8 (1878).
[2] Day, *Journ. Linn. Soc. London* (Zool.) XI, p. 529 (1873).
[3] Fowler, *Proc. Acad. Nat. Sci. Philadelphia* LXXVI, p. 71 (1924).

anterior to the dorsal fin, break up and form numerous narrow bands as has already been figured in the case of the Garro Hills specimens.



Text-fig. 2.—Lateral view of *Nemachilus beavani* Günther. ×2.
a. Fresh specimen from the Darjeeling Himalayas.
b. Sketch* of the type-specimen in the British Museum.

* In sending the sketch, Mr. J. R. Norman observed that " Markings are very faded and indistinct—with exception of dark band across base of caudal and dark spots on rays of dorsal fin."

Nemachilus beavani is fairly abundant in small streams at the base of Eastern Himalayas. In specimens obtained from very fast currents, there is invariably a well-developed fleshy appendage in the axil of the pectoral fin. The ventral fins are also provided with fleshy appendages.

Nemachilus scaturigina (McClelland).

(Plate III, figs. 7-8.)

1839. *Cobitis* (*Schistura*) *scaturigina*, McClelland, *As. Res.* (Ind. Cyprinidae, XIX, pp. 308, 443, pl. liii, fig. 6.
1839. *Cobitis* (*Schistura*) *subfusca*, McClelland, *ibid.*, p. 308, 413, pl. liii, fig. 5.
1846. *Cobitis subfusca*, Cuvier & Valenciennes, *Hist. Nat. Poiss.* XVIII, p. 80.
1854. *Cobitis scaturigina*, Bleeker, *Verh. Bat. Gen.* XXV, p. 70 (name only).
1854. *Cobitis subfusca*, Bleeker, *ibid.*, p. 70 (name only).
1868. *Nemachilus subfuscus*, Günther, *Cat. Fish Brit. Mus.*, VII, p. 351.
1868. *Cobitis scaturigina*, Günther, *ibid.*, p. 347 (foot-note).
1877. *Nemachilus subfuscus*, Beavan, *Freshwater Fish Ind.*, p. 108.
1878. *Cobitis scaturigina*, Day, *Fish India*, p. 614 (reference under *Nemachilus botia*).

Nemachilus scaturigina was described by McClelland in his account of the Indian Cyprinidae, but he assigned the authorship to Hamilton-Buchanan under a misapprehension. The species was described from a figure in the Royal Botanical Garden at Calcutta and McClelland remarked that " This species is also without suborbital spines, and in my opinion is nearly allied to S. subfusca ; the ventrals are, however, round, and the rays of the dorsal are marked on the middle with a brown spot. I cannot find this species referred to in the *Gangetic Fishes*, though

it is figured in Buchanan's collection." It is now well-known that Hamilton left behind in India drawings of 144 species of fish and 13 years later when McClelland examined them there were 150 drawings. There is no doubt, therefore, that 6 of these drawings did not belong to Hamilton's collection and had been added to it later, possibly by Wallich. I have shown elsewhere[1] that one of these six drawings is *Cobitis scaturigina*, to which there is no reference even in Hamilton's 'Original Notes' concerning the "Gangetic Fishes."

McClelland found the drawing labelled as "*Cobitis scaturigina*" and adopted this name for the species. The drawing is still preserved among Hamilton's collection of drawings in the Library of the Asiatic Society of Bengal (No. 53 of Volume IV), but unfortunately it bears no name and it is difficult, therefore, to decide about the actual authorship of the name. Day[2] did not find the name on the plate when he examined these illustrations in 1871. In view of these circumstances and the fact that McClelland introduced this species in scientific literature with a distinct indication, the authorship of the species should be assigned to him.

McClelland regarded *Cobitis scaturigina* as a close ally of his *C. subfusca* from "Upper Assam" and his figures of the two species indicate close similarity. From a study of the large material obtained at the base of the Darjeeling Himalayas, I find that the two forms are identical, though they represent colour variations in the same species, I have adopted the name *scaturigina* in preference to *subfusca* for the simple reason that the former is characterised before[3] the latter in McClelland's work (p. 308).

Between 1815, when Hamilton left India, and 1838, when McClelland examined Hamilton's collection of fish drawings, it is known that Wallich and Hardwicke used this collection extensively and had copies made of some of the drawings. It is also known that both Wallich and Hardwicke had drawings made of species not represented in Hamilton's collection, and further it is known that both these workers paid frequent visits to the Darjeeling Himalayas and made collections of fish there. Whereas Hardwicke's illustrations were published by Gray,[4] it is likely that drawings made by Wallich were kept mixed up with Hamilton's collection. I presume that the drawing of *Cobitis scaturigina* belonged to Wallich and was executed from a specimen collected below Darjeeling Himalayas. If this be so, the specimens obtained at Sevoke and other places represent topotypes of the species.

Both *scaturigina* and *subfusca* had a chequered career and their specific identity has not been elucidated so far. Cuvier and Valenciennes and Bleeker described them from McClelland's brief descriptions and figures. Günther regarded *scaturigina* as a doubtful species and gave a brief description of *subfusca* after McClelland. According to Day, "The *Cobitis scaturigina* McClell. is an elongated variety of *Nemachilus botia*, the height of the body being about 6½ in the total. I have obtained

[1] Hora, *Mem. Ind. Mus.* IX, p. 173 (1929).
[2] Day, *Proc. As. Soc. Bengal*, p. 202 (1871).
[3] The order of precedence is changed on page 443, but this is immaterial.
[4] Gray, *Illustrations of Indian Zoology*, 2 vols. (London: 1832).

it in Assam." It is impossible to say how Day came to this conclusion for there is not the least likeness between the figures of *scaturigina* and *N. botia*. The general facies, the colouration and the form of the caudal fin are absolutely different in the two species. *Schistura subfusca* was included by Day with a query in the synonymy of his *Nemachilus multifasciatus* which was described from Darjeeling and Assam. It is shown here that *N. multifasciatus* is a very characteristic species distinguished by the colouration of the dorsal and caudal fins and is quite distinct from McClelland's species.

In the collection of the British Museum, there are five specimens (No. 72.4.17.32), collected in North-east Bengal by Dr. T. C. Jerdon, labelled as *N. scaturigina*. This seems to be a mixed lot as the two specimens loaned to me for examination from the British Museum belong to two species—*N. scaturigina* and *N. beavani*. Though the colour is very much faded, the two species can be readily distinguished by the position of the anus with reference to the ventral fins.

In view of the great confusion prevailing about the specific limits of *N. scaturigina*, it may be redescribed as follows :—

D. 2/7 ; A. 2/5 ; P. 10 ; V. 8 ; C. 19.

Nemachilus scaturigina is a small, elongated species in which both the dorsal and the ventral profiles are almost straight and horizontal. The ventral surface is somewhat flattened in front of the ventral fins. The head is long, narrow and pointed anteriorly ; its length is contained 4·2-4·5 times in the total length without the caudal. The width of the head is contained 1·4-1·6 times and the height of the head 1·6-1·8 times in its length. The snout is somewhat longer than the postorbital part of the head. The eyes are dorso-lateral in position and are not visible from the ventral surface. The diameter of the eye is contained 4-5·3 times in the length of the head; 1·6-2·2 times in the length of the snout and is almost equal to or is contained up to 1·4 times in the interorbital width. The mouth is small, semicircular and horizontal; it is situated on the ventral surface behind the tip of the snout and is bordered by fleshy lips. The lower lip is interrupted and reflected towards the sides in the middle. The lips are plain without corrugations, but they may be slightly crenulated. The lower jaw is sharp and shovel-like and the upper jaw is vertical and lies in front of the lower jaw. In the male specimens, there is a fleshy, loose pad below the eye and the upper surface of the anterior pectoral rays is tuberculated. All the three pairs of barbels are longer than the eye, but the outer rostral barbels are the longest.

The body is narrow and elongated ; its depth is contained from 5·4 to 6·5 times in the total length without the caudal. It is covered with small, inconspicuous scales which are somewhat more prominent in the tail region and are absent from the ventral surface. The lateral line is complete, and runs in a narrow groove along the middle of the body. The caudal peduncle is short and high ; its least height is contained 1·1-1·5 times in its length.

The dorsal fin begins in advance of the ventrals and its commencement is almost equidistant between the tip of the snout and the base

of the caudal fin; its anterior margin is slightly rounded but the posterior margin is obliquely truncate. The longest ray of the dorsal is usually longer than the depth of the body below it. The paired fins are horizontally placed and pointed in the middle. In the mature males, the first two rays are broad and elongated, while a number of the outer rays are provided with tubercles on the dorsal surface. The pectoral fin is separated from the ventral by a considerable distance. The ventral fin does not reach the anal opening. The caudal fin is emarginate with both the lobes pointed.

In spirit specimens the head and body are grayish above and pale-olivaceous below. There are about 9 to 12 saddle-shaped, narrow, dark bands which descend on the sides from the dorsal surface, but do not extend to the ventral surface. In some specimens, the bands are interrupted, so they appear as series of blotches irregularly distributed. Sometimes the bands are split up into secondary bands. This condition becomes more pronounced in front of the dorsal fin and in extreme cases results in the *multifasciatus*-type of colouration. There is a narrow black bar at the base of the caudal fin and one or two series of dots forming a V-shaped pattern on the fin itself. The rays of the dorsal fin are also infuscated in the middle. There is a black spot at the base of the anterior dorsal rays.

Distribution.—Eastern Himalayas and Assam. Most of the specimens in the collection of the Zoological Survey of India were obtained from small streams at the base of the Darjeeling Himalayas. *N. scaturigina* is not as common as *N. rupecola* var. *inglisi*, *N. savona* or *N. devdevi*.

Measurements in millimetres.

Total length without caudal	41·0	43·3	44·6	42·5
Length of caudal	11·0	11·3	12·0	Damaged
Depth of body	6·3	8·0	7·5	7·0
Length of head	9·5	9·8	9·8	10·0
Width of head	6·0	6·7	6·7	6·0
Height of head at occiput	5·3	6·0	5·8	5·3
Length of snout	4·0	4·0	4·0	3·6
Diameter of eye	1·8	2·2	2·5	2·0
Interorbital width	2·6	2·4	2·5	2·5
Longest ray of dorsal	8·6	7·3	8·0	8·3
Longest ray of anal	6·5	7·0	8·0	6·5
Length of pectoral	9·8	10·0	1·0	9·0
Length of ventral	7·0	7·6	7·0	7·0
Length of caudal peduncle	6·0	7·0	6·8	6·0
Least height of caudal peduncle	4·7	4·5	5·5	5·6
Distance between tip of snout and commencement of dorsal	21·2	22·0	22·0	21·5
Distance between commencement of pectoral and that of ventral	13·0	13·0	13·5	13·0

EXPLANATION OF PLATE III.

Nemachilus shebbearei, sp. nov.

FIG. 1.—Lateral view of type-specimen. $\times 2$.
FIG. 2.—Ventral surface of head and anterior part of body of same. $\times 2$.

Nemachilus savona (Ham. Buch.).

FIG. 3.—Lateral view. $\times 2\frac{2}{3}$.
FIG. 4.—Ventral surface of head and anterior part of body. $\times 2\frac{2}{3}$.

Nemachilus devdevi, sp. nov.

FIG. 5.—Lateral view of type-specimen. $\times 2\frac{1}{3}$.
FIG. 6.—Ventral surface of head and anterior part of body of same. $\times 2\frac{1}{3}$.

Nemachilus scaturigina (McClelland).

FIG. 7.—Lateral view. $\times 2$.
FIG. 8.—Ventral surface of head and anterior part of body. $\times 2$.

Nemachilus rupecola var. *inglisi*, nov.

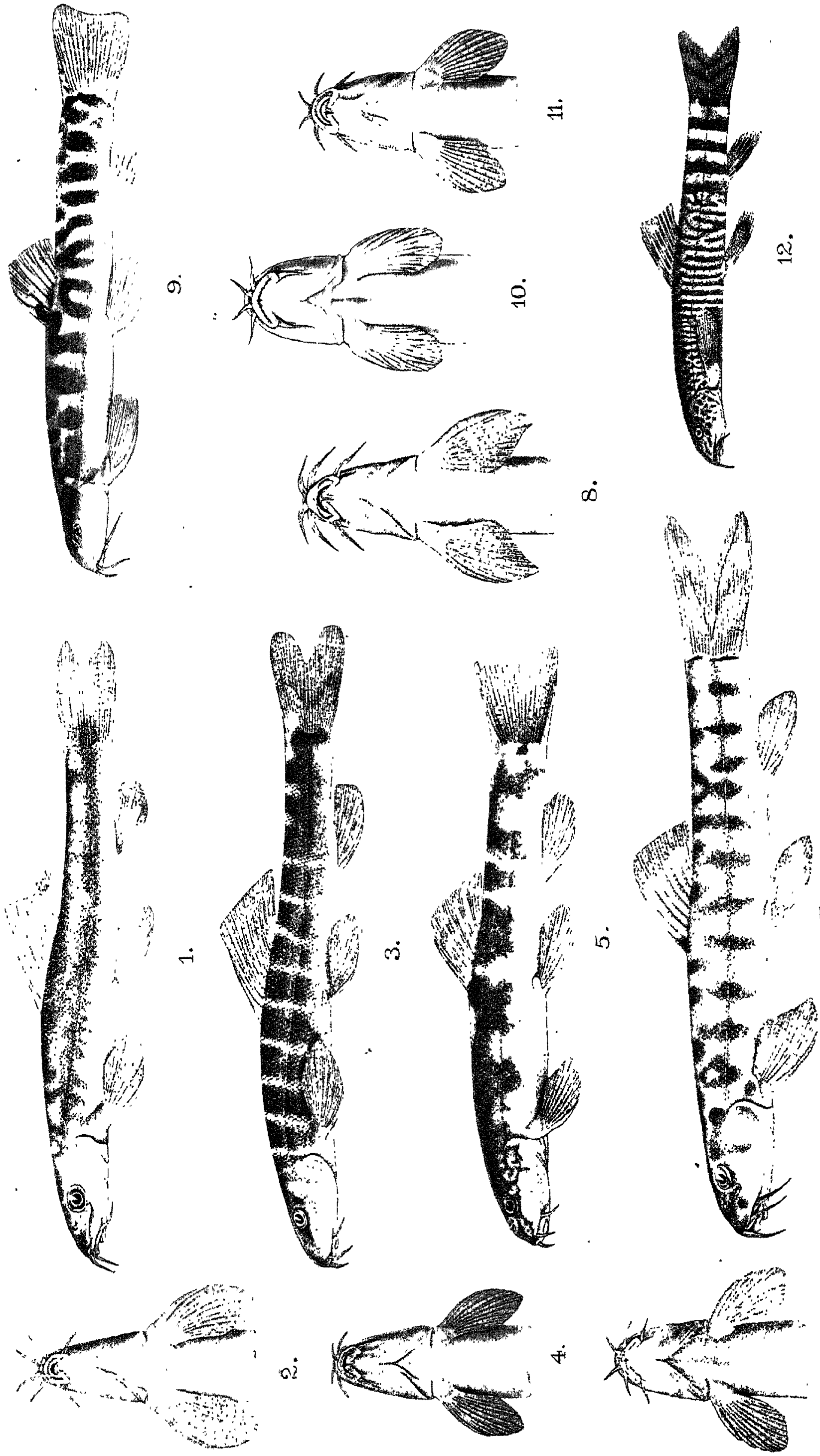
FIG. ~~9.—Lateral~~ view. Nat. size.
FIG. 10.—Ventral surface of head and anterior part of body. Nat. size.

Nemachilus beavani Günther.

FIG. 11.—Ventral surface of [illegible]erior part of body. $\times 2$.

Nemachilus vinciguerrae, sp. nov.

FIG. 12.—Lateral view of one of Vinciguerra's Burmese specimen of "*Nemachilus multifaciatus*". Nat. size.

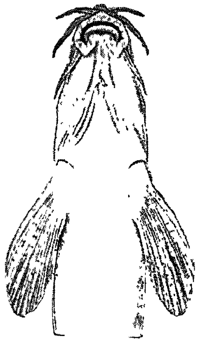


Nemachilus from Eastern Himalayas.

R. Bagchi, del.

[REPRINTED FROM THE *Journal of the Bombay Natural History Society*, *Vol. XXXVII, No. 4, dated 15-4-1935.*

ON A COLLECTION OF FISH FROM AFGHANISTAN. BY SUNDER LAL HORA, D.SC., F.R.S.E., F.A.S.B. (*With a plate and 4 text-figures.*)



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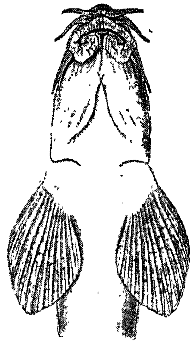

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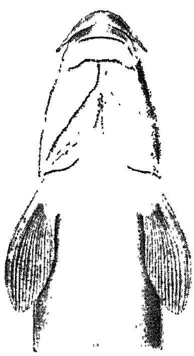

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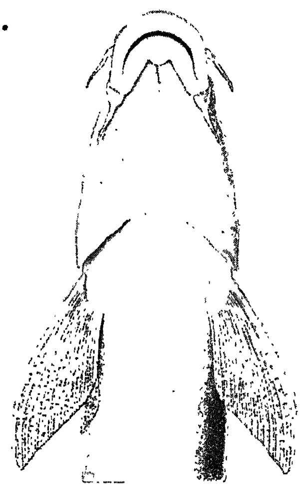

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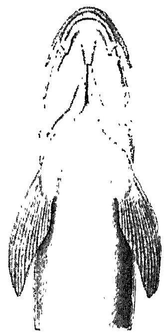

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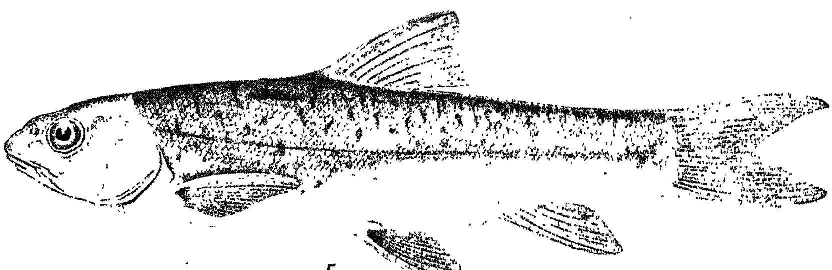

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FISHES OF AFGHANISTAN.

Fig. 1.—Ventral surface of head and anterior part of body of a young specimen of *Nemachilus* sp. prox. *griffithii* Günther. ×1 3/5.
Fig. 2.—Ventral surface of head and anterior part of body of the type-specimen of *Nemachilus farwelli*, sp. nov. Nat. size.
Fig. 3.—Ventral surface of head and anterior part of body of *Oreinus sinuatus* var. *griffithii* McClell. ×4/5.
Fig. 4.—Ventral surface of head and anterior part of body of *Schizothorax chrysochlora* (McClell.). ×4/5.
Fig. 5.—Lateral view of *Barbus capito conocephalus* × *Schizothorax* sp. ×1 1/5.
Fig. 6.—Ventral surface of head and anterior part of body of the above hybrid. ×1 1/5.

[FROM THE JOURNAL OF THE BOMBAY NATURAL HIST. SOC., *April* 15, 1935.]

ON A COLLECTION OF FISH FROM AFGHANISTAN.

BY

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(*With a plate and 4 text-figures*)

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In 1933, in the *Journal* of the Society an account was given of the fish of Afghanistan (vol. xxxvi, No. 3, pp. 688-706, 2 pls. and 2 text-figs.) and a small collection of five specimens was dealt with. During 1933, Sir Richard Maconachie, Major A. E. Farwell and Capt. E. W. Fletcher sent further material from Afghanistan to the Bombay Natural History Society which was kindly forwarded to me by Mr. S. H. Prater for examination and report. I am deeply indebted to these gentlemen for affording me an opportunity to report on a very valuable collection which has helped greatly in understanding the precise specific limits of a number of McClelland's hitherto ill-defined species from this country. Sufficient stress cannot be laid on the fact that, with the increased knowledge of the ichthyology of Afghanistan, the taxonomy and geographical distribution of the Central Asiatic fishes will become clear, and it will then be possible to standardise the classification of the fishes of this vast region.

The collection reported below was made at different places in all the three main river basins of Afghanistan: namely, those of the Kabul, the Helmand and the Oxus. At my request the collectors have supplied short ecological notes on the various localities in which the fish were collected and I propose to give below a list of these stations with the names of species collected therefrom.

KABUL SYSTEM.

1. *Sar-i-Chashma.*—'The head springs of the Kabul river. Bottom stony, water clear and swift. Water cress and such like vegetation on the banks' (Major A. E. Farwell).

i.	*Oreinus sinuatus* var. *griffithii* McClell.	1 specimen.
ii.	*Nemachilus griffithii* var. *afghana*, nov.	4 specimens.

2. *Chahiltran stream.*—'A tributary of the Kabul river about 6 miles west of the Kabul City. The small stream has a pebbly bottom and has water cress and such like vegetation on its banks (Sir R. Maconachie).

i. *Nemachilus griffithii* var. *afghana*, nov. 1 specimen.

3. *Logar river.*—'Has a muddy bed and somewhat sluggish current. Runs through cultivation,—rice, wheat and barley predominating. No information as to where fish were caught, but believed to be in a pool' (Major A. E. Farwell). The Logar river is a tributary of the Kabul river; it arises in the Gul-Koh on the south

about 70 miles west of Kabul and joins the Kabul river about 10 miles below Kabul City. It has a length of about 200 miles and at its junction is as large as the Kabul river itself.

i. *Schizothorax intermedius* McClell. 2 specimens.
ii. *Schizothorax chrysochlora* (McClell.). 2 specimens.

HELMAND SYSTEM.

1. *Helmand river* (no definite locality is indicated).

i. *Nemachilus farwelli*, sp. nov. 1 specimen.

2. *Sar-i-Bulak stream.*—A tributary of the Helmand river 'approximately 100 miles due west of Kabul as the crow flies. Pebbly bottom, clear water, swift current. Little vegetation but barley and lucerne cultivation in places' (Major A. E. Farwell).

i. *Nemachilus* sp. prox. *griffithii* Günther. 17 specimens.

OXUS SYSTEM.

1. *Darra Ashraf* and *Margh streams.*—'Mountain rivers on the north side of Hindukush. Rocky, stony bottoms, clear water and swift current. They join the Bamain river (there known as Surkhab) at Tala which is roughly 85 miles north-west of Kabul as the crow flies' (Major A. E. Farwell).

a. Darra Ashraf:—

i. *Salmo trutta aralensis oxianus* Kessler. 2 specimens.

b. Margh:—

i. *Salmo trutta aralensis oxianus* Kessler. 1 specimen.
ii. *Alburnoides bipunctatus* var. *eichwaldi* (Filippi). 1 specimen.

2. *Anderab river at Banu.*—The Anderab river 'rises on north-west side of Hindukush at Khawak Pass (35°40′ N., 69°45′ E.). Flows due west through Banu to Doshi (35°40′ N., 68°40′ E.) where it joins Surkhab which flows north into Oxus at about Kudukh Toba (37° N., 68°20′ E.). Bed rocky at Banu with a few deep pools. Current very rapid and water in July was very discoloured owing to irrigation of rice fields which line the banks. Willow fairly numerous along the banks, mulberry trees further inland. The two fish were taken in a small shallow backwater' (Capt. E. W. Fletcher).

i. *Glyptosternum reticulatum* McClell. 1 specimen.
ii. *Barbus capito conocephalus* × *Schizothorax* sp. (Hybrid). 1 specimen.

Capt. E. W. Fletcher has kindly supplied the following additional notes on the fish fauna of the Anderab river:—

'Local fishermen catch many "Chush"[1] in this stream with

[1] So far as my information goes, the local name 'Chush' or 'Choosh' is used in Kashmir for *Schizothorax micropogon* Heckel, though Heckel gave 'Ramghurdi' as its local name. *Sch. micropogon* is probably not found outside the Kashmir Valley, but it seems likely that in the name 'Chush' Capt. Fletcher makes a reference to a species of *Schizothorax*, of which, unfortunately, he did not collect a specimen. In the fishes collected by him from the Anderab river at Banu, there is a hybrid between a *Barbus* and a *Schizothorax* and it seems likely that both the genera are well represented in the Anderab river.

mulberries and they also catch trout[1] with slices of "Chush" on a hook. Twelve miles south of Banu lies the Arzu pass from which a small stream of the same name flows north to join the Anderab at Banu. This stream contains no "Chush" but is full of Oxus trout. About 6 miles from Banu it flows through a narrow gorge where there are many rocks. The current here is very swift and trout abound. In July 1933 trout were taken easily on locusts and averaged ½ to ¾ lb., running up to 1½ lb. Only one was taken on a fly. The vegetation consisted chiefly of grass and small scrub bushes, but rice cultivation and willow trees lined the banks up to about 3 miles north of Banu.

'At Khinjan (35°40′ N., 68°50′ E.) the Khinjan River flows into the Anderab from the south. This stream holds "Chush" certainly up to 3 miles from its junction with the Anderab. The vegetation consists chiefly of mulberry trees with some fields near the junction. Higher up, the banks are lined with small bushes and grass. About 14 miles from Khinjan trout were taken on fly in July. They averaged ½ lb. to ¾ lb. and ran up to 1½ lb. The stream was very swift and rocky. There were few locusts to be seen here and, in contradistinction to the Arzu stream, the trout would not look at them.'

It will be seen from the above that the collection dealt with here comprises only 34 specimens belonging to nine species or varieties and a hybrid form. Through the kindness of Dr. C. Tate Regan and Mr. J. R. Norman, a type-specimen of *Nemachilus griffithii* was sent to me for study and I have availed myself of this opportunity to add a few further notes on the species and to give a drawing of the specimen. The specimens from the Paghman river described under this specific name in 1933, as well as those obtained at Sar-i-Chashma and in the Chahiltran stream as noted above, are separated into a new variety *afghana* of *N. griffithii*. A very characteristic new species of *Nemachilus* is described from the Helmand river. *Schizothorax chrysochlora* (McClelland) is described in detail for the first time, and the probable specific limits of *Sch. intermedius* McClelland are indicated. *Oreinus sinuatus* var. *griffithii*, *Alburnoides bipunctatus* var. *eichwaldi*, *Salmo trutta aralensis oxianus*, and *Glyptosternum reticulatum* are recorded from new localities. A full description of a hybrid form between a *Barbus* and a *Schizothorax* is given.

Through the generosity of the Bombay Natural History Society it has been possible to illustrate the paper adequately, and I have great pleasure in offering my sincerest thanks to Mr. S. H. Prater for his kind interest. Mr. R. Bagchi has delineated the fishes under my supervision with his usual skill and care, and my best thanks are due to him for this.

The material is preserved in the collection of the Zoological Survey of India, with the exception of a few specimens of loaches sent to the British Museum (Natural History). The types are deposited in the Indian Museum.

[1] The commonest trout in these parts is *Salmo trutta aralensis oxianus* Kessler.

Salmo trutta aralensis oxianus Kessler.

1842. *Salmo orientalis*, McClelland (*nec* Pallas), *Calcutta Journ. Nat. Hist.* ii, 585.
1843. *Salmo orientalis*, McClelland (*nec* Pallas), *Calcutta Journ. Nat. Hist.* iii, pp. 283-287.
1874. *Salmo oxianus*, Kessler, 'Pisces' in Fedtschenko's *Reise in Turkestan*, p. 35.
1932. *Salmo trutta aralensis* Berg morpha *fario* L., Berg. *Poiss. Eaux Douces de l' U.R.S.S. et des Pays Limitrophes* 3rd. Edition, i, p. 161 (See earlier references).
1933. *The Bamean Trout*, Hora, *Journ. Bombay Nat. Hist. Soc.* xxxvi, pp. 700-705, pl.-figs. 3 & 4, 2 text-figs.

In the recent collection of fish from Afghanistan, there are 3 specimens of the Bamean Trout, the largest is about 150 mm. in total length. Two of these were caught in the Darra Ashraf and one in the Margh stream. These two streams are 4 miles apart and run into the Surkhab river (Bamean river) which is a tributary of the Oxus.

Through the kindness of Prof. L. Berg, the Zoological Survey of India now possesses one of the typical specimens of *Salmo oxianus* Kessler (No. 2840 of the Zoological Museum at Leningrad). It is 208 mm. in total length and is in a very good state of preservation. It was obtained from 'Kyzyl-su river, Basin of the Upper Amu-darya, Alai Valley, Pamir'. A comparison between this and the Afghanistan specimen has shown that they are absolutely identical with the exception of such characters which are liable to vary with the length of the individuals.

The specimens from Afghanistan are in the Parr state and possess the characteristic colouration.

The vernacular name of the trout is *Māhī-i-Khāldār* which literally means 'a fish with spots'. I am informed that in standard Persian it is called *māhī-i-qizil-ālā* 'the red-speckled fish' and in the Turkish-speaking provinces of Persia *āla-bāliq* 'the spotted fish'. The Afghan name (not Kabuli but Persian) is, in view of the characteristic colouration, very appropriate.

Glyptosternum reticulatum McClelland.

1933. *Glyptosternum reticulatum*, Hora, *Journ. Bombay Nat. Hist. Soc.* xxxvi, p. 697 (see for earlier references).

A fine specimen of *Glyptosternum reticulatum*, 196 mm. in total length, was collected by Capt. E. W. Fletcher from the Banu Andrab river, about 79 miles north of Kabul at an altitude of 4,300 ft. The entire dorsal and lateral surfaces of the fish are reticulated with blackish spots and markings, and it is likely that such a colour-pattern may have been responsible for the specific name *reticulatum*. The caudal fin and the distal half of the anal fin are more deeply pigmented. The ventral surface in front of the ventral fins is roughened by small and hard papillae. The adipose dorsal is well developed, it is as long as the tail portion of the body without the caudal fin and its height is equal to half the width of the mouth.

In the group of the Sisorid fishes to which *Glyptosternum* belongs, a new genus—*Oreoglanis*—has been described recently by Smith.[1] To indicate the relationship of this genus, he has given a key to the genera of Glyptosternoid cat-fishes. Moreover, he has indicated that, as already pointed out by me,[2] *Parexostoma* Regan is synonymous with *Glyptosternum* McClelland.

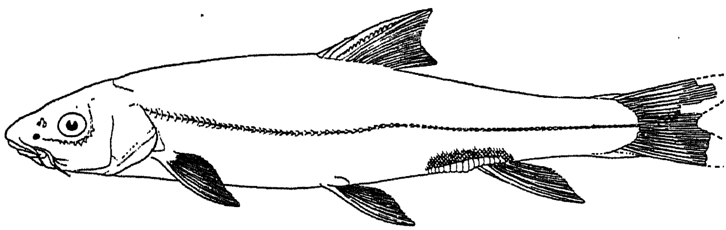
G. reticulatum has recently been found at two different places within the limits of Afghanistan.

Schizothorax intermedius McClelland.

1842. *Schizothorax intermedius*, McClelland, *Calcutta Journ. Nat. Hist.* ii, p. 579.

1868. *Schizothorax intermedius*, Günther, *Cat. Fish. Brit. Mus.* vii, p. 165.

In grouping species of *Schizothorax*, McClelland included *Sch. intermedius* and *Sch. esocinus* among those forms in which the lower lip presents 'a free reflected margin only at the angles of the mouth'. Besides this character, there is no other indication in the description of the former species by which it could be distinguished from the allied forms. Unfortunately McClelland did not publish any drawing of the species, so its determination would have always remained a guess-work had McClelland not sent 3 specimens of the species to the 'Museum at the India House', whence two examples (stuffed, 11 in. long and skin, 9 in. long) passed to the collection at the British Museum and served for the description of the species by Günther in his *Catalogue of Fishes*. I have no doubt that Günther had before him the typical specimens of the species. In the collection of fish from Afghanistan, there are two specimens—badly preserved and somewhat damaged—which agree very closely with Günther's description of *Sch. intermedius*. These were collected in the Logar river, a tributary of the Kabul river, to the south of Kabul. It is significant that the original specimens of the species were collected by Griffith in the Kabul river at Jallalabad and in the Tarnuck river.



Text-fig. 1.—Lateral view of *Schizothorax intermedius* McClelland. × ½.

From Günther's description of *Sch. intermedius* and from an examination of specimens before me, the following salient characters of the species may be mentioned:—

(i) Lower labial fold interrupted in the middle.

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[1] Smith, *Journ. Siam Soc., Nat. Hist. Suppl.* ix, pp. 70-74, pl. iii, 1 text-fig. (1933).

[2] Hora, *Ann. Mag. Nat. Hist.* (10) x, pp. 176-179 (1932); *Cur. Sci.* i, p. 130 (1932).

(ii) Commencement of dorsal fin nearly midway between the tip of the snout and the base of the caudal fin.
(iii) Eyes situated not entirely in the anterior half of the head.
(iv) Anal scales not much developed, the largest being scarcely half as broad as the orbit.
(v) Height of head at occiput considerably greater than its width.
(vi) Body without spots.

A perusal of the literature shows that a very wide interpretation has been given to *Sch. intermedius* and that several unrelated forms have been designated by this title. The confusion seems to have been started by Day,[1] who, in 1876 and 1878, described and figured specimens from Kashgar, Yangihissar and Sirikol as *Sch. intermedius*. I have examined some of these specimens in the collection of the Indian Museum, and find that in all of them the eye is situated entirely in the anterior half of the head, and that the anal scales are relatively larger. The dorsal spine is stronger and more coarsely serrated, and the scales are relatively much larger in size. Herzenstein[2] relegated *Sch. aksaiensis* Kessler and *Sch. affinis* Kessler to the rank of the subspecies of *Sch. intermedius* and described *malacorrhynchus* as a new subspecies. Berg[3] in his latest work has given a comprehensive scheme of classification of the various subspecies of *Sch. intermedius*. I am unable to agree to the system proposed by Berg, and in the absence of sufficient material of the Central Asiatic forms associated with McClelland's species, I am unable to define the specific limits of these forms. In order to facilitate reference, I give below a table of measurements of the two specimens, but it has to be understood that, due to the damaged condition and poor preservation of the specimens, some of the measurements are likely to be faulty.

Measurements in millimetres

Total length without caudal	96·0	156·0
Length of head	25·0	38·0
Height of head	15·2	25·8
Width of head	13·3	22·2
Length of snout	9·0	13·8
Diameter of eye	6·8	6·7
Interorbital width	7·8	13·5
Depth of body	18·5	30·0
Longest ray of dorsal	19·0	28·0
Longest ray of anal	16·5	26·8
Length of pectoral	19·8	28·0
Length of ventral ...	17·3	25·4
Length of caudal peduncle ...	17·3	27·0
Least height of caudal peduncle	8·5	14·5

[1] Day, *Proc. Zool. Soc. London*, p. 786 (1876); Ichthyology, *Sci. Res. 2nd Yarkand Miss.*, p. 5 (1878).

[2] Herzenstein, 'Fische', in *Wiss Res. Przewalski Central As. Reis. Zool. Theil*, iii (2), pp. 106-117 (1889).

[3] Berg, *Poissons des Eaux Douces de l' U.R.S.S.*, i, pp. 458-462 (1932). See earlier references.

Local name:—The two specimens of *Sch. intermedius* were sent with the two specimens of the following species under the common name *Sheer-Māhi*.

Schizothorax chrysochlora McClelland.

(Pl.-fig. 4; text-fig. 2.)

1842. *Racoma chrysochlora*, McClelland, *Calcutta Journ. Nat. Hist. Soc.* ii, p. 577, pl. xv, fig. 2.

Schizothorax chrysochlora was described by McClelland from Mr. Griffith's notes and the figure is stated to have been 'reduced from his very excellent drawing'. The diagnosis of the species is very poor and of a generalized nature. It reads as 'Mouth directed forward, intermaxillaries protractile, without spots, scales small, raised on the lateral line, vertical anal scales large, colour brownish yellow, operculum square behind, intestine convoluted in a conical form in the anterior part of the abdomen, and equal to six lengths of the body'. *Sch. chrysochlora* is stated to grow to a length of 10 inches and was collected in the Kabul river at Lalpore. At Lalpore, Mr. Griffith 'procured a fish I believe identical with the nepoora of Assam, *C. falcatus* of Hardwicke, a Barbus, a Gonorhynchus, a small Mahasir, and a remarkable fish, which appears to me the type of *types* of Carnivorous *Poconominae*'. It would thus appear that *Sch. chrysochlora* was obtained from the lower region of the Kabul river where there is a mixture of the Indian and Central Asiatic species of fishes. Under the description of *Racoma labiatus*, McClelland says: 'Mr. Griffith remarks that this singular form is nearly allied to the Lalpore species, but that the intestines of the latter are infinitely longer, nor is there any enlargement of the lips in the latter; but this last character Mr. Griffith remarks is not so remarkable in young specimens'. It is this indication of a close similarity between *labiatus* and *chrysochlora* that has helped me in assigning two badly preserved and damaged specimens from the Logar river, a tributary of the Kabul river, to *Sch. chrysochlora*. *Sch. labiatus* is the commonest species in the Chitral Valley, whence my colleague, Dr. B. N. Chopra, obtained a large series of nicely preserved specimens. This material has proved very useful in studying the form referred to as *Sch. chrysochlora* by McClelland.

In 1876, Day[1] described and two years later figured certain specimens collected by the Second Yarkand Mission at 'Kashghar, Yangihissar, and Yarkand' as *Sch. chrysochlorus*. In the collection of the Zoological Survey of India, there are several specimens purchased from Day and labelled as *Sch. chrysochlorus*. In these specimens the eye is entirely in the anterior half of the head, which is low and elongate. The snout is also very long and the fold of the lower lip does not extend beyond the symphysis. The anal scales are but little developed. In McClelland's *Sch. chrysochlora* the vertical anal scales are large and the fold of the lower lip is

[1] Day, *Proc. Zool. Soc. London*, p. 784 (1876); *Sci. Res. 2nd Yarkand Miss.*, Ichthyology, p. 3, pl. i, fig. 2 (1878).

free throughout and somewhat trilobate as in *Sch. labiatus.* It would thus appear that Day's identification of the Yarkand Mission specimens as *Sch. chrysochlora* was not correct and that they in reality belong to *Sch. biddulphi* Günther.[1]

It would thus appear that since its discovery, *Sch. chrysochlora* has remained unknown and that both the description and figure of it by McClelland have not proved sufficient for elucidating its precise specific limits. Günther[2] included it among other ill-defined species of *Schizothorax*, and in 1889[3] doubted the use of the name by Day for a species from Yarkand. This point was elaborated by Herzenstein[4] who showed that Day was not justified in applying McClelland's name *Sch. chrysochlora* to a species so different from McClelland's original form.

From McClelland's original description and figure of *Sch. chrysochlora*, the following salient features may be noted, though the description is certainly very meagre and applicable 'to more than one species of *Schizothorax*' as remarked by Günther.

(i) Body without spots.

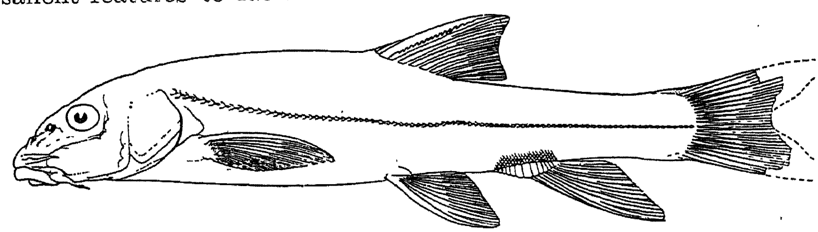
(ii) 'Scales small, raised on the lateral line, *vertical anal scales large*' (italics are mine).

(iii) The head is short and high.

(iv) The eye is situated almost in the middle of the length of the head.

(v) The species is found in the lower reaches of the Kabul river where certain species of the Indian fauna are also found.

The two specimens before me agree in all these points with McClelland's description, but unfortunately they are not in a good state of preservation and, therefore, a detailed description cannot be given. Attention may, however, be directed to some of the salient features to facilitate reference in future.



Text.-fig. 2.—Lateral view of *Schizothorax chrysochlora* (McClelland). ×½.

[1] Günther, *Ann. Mag. Nat. Hist.* (4), xvii, p. 400 (1876).

Schizothorax biddulphi was described by Günther from two skins, the larger being 15.5 in. long. In Day's specimens and description of *Sch. chrysochlorus* the length of the head is about 4⅘ to 5⅓ in the total length, but Günther says 'one-fifth of the total (without caudal)'. Günther usually excluded the caudal fin in giving the total length, but in this case I believe he meant to say 'with caudal'. In all other respects Day's *Sch. chrysochlorus* and Günther's *Sch. biddulphi* appear to be almost identical.

[2] Günther, *Cat. Fish. Brit. Mus.*, vii, p. 162 (1868).

[3] Günther, *Trans. Linn. Soc. London* (2), v, p. 107 (1889).

[4] Herzenstein, 'Fische', in *Wiss. Res. Przewalski Central Asi. Reis. Zool. Theil*, iii (2), pp. 154-156 (1889).

D. 3/8; A. 3/5; P. 20; V. 10.

The dorsal profile rises abruptly from the tip of the snout to the nape and then gently to the base of the dorsal fin beyond which it slopes down to the base of the caudal fin. The ventral profile in front of the anal fin is almost straight or only slightly arched. The ventral surface of the head and the anterior part of the body is somewhat flattened. In the larger specimen, the maxillaries are protruded and the length of the head cannot be ascertained accurately. The length of the head is contained from 3·5 to 3·7 times in the total length without the caudal. The width of the head is contained 1·7 to 1·8 times and the height of the head 1·6 to 1·7 times in its length. The eye is dorso-lateral in position and is barely visible from the ventral surface; in the smaller specimen it is situated considerably nearer to the tip of the snout than to the posterior margin of the operculum, but in the larger specimen the eye is almost in the middle of the length of the head. The diameter of the eye is contained 4·7 to 5·0 times in the length of the head, 1·5 to 2·3 times in the length of the snout and 1·2 to 1·6 times in the interorbital width. These proportions indicate that the eyes undergo considerable variation both in size and position with the growth of the fish. The interorbital space is broad and flattened. The mouth is subterminal, transverse and arched; it is bordered by thick lips which are continuous all round the mouth so that the reflected posterior margin of the lower lip is entire. In the larger specimen, this labial fold is trilobed. The edge of the lower jaw is sharp and strong, and is covered with a horny covering. The barbels are subequal and longer than the diameter of the eye. The depth of the body is contained 5·2 times in the total length without the caudal. The scales are small, but those on the lateral line are somewhat larger and raised. There are several transverse rows of larger scales behind the gill-opening, and the anal scales are almost as long as half the diameter of the eye. The ventral surface between the pectorals is devoid of scales. The lateral line is complete and runs to the middle of the base of the caudal fin.

The dorsal fin arises slightly in advance of the ventrals and its commencement is considerably nearer the base of caudal than the tip of the snout. The last dorsal spine is bony, but quite flexible in the distal one-third of its length, and is serrated along the posterior border. The longest ray of the dorsal fin is shorter than the depth of the body. The pectoral, ventral and anal fins are long and pointed, but none of these fins, when laid flat, reaches the one following it. The caudal fin is damaged in both the specimens, but McClelland's figure shows it to be a deeply bifurcate structure. The anal opening is situated just before the anal fin. There is an adnate scaly appendage in the axil of the ventral fin. The caudal peduncle is about 1·7 to 1·9 times as long as its least height.

The colour is greyish above the lateral line, pale-olivaceous below it and much lighter on the ventral surface.

Remarks.—As remarked by Griffith, *Sch. chrysochlora* has much in common with *Sch. labiatus* McClelland, and especially with those specimens of the latter in which the labial fold is not well-developed. I have dealt with the variation exhibited by *Sch. labiatus* in my report on the Chitral Fishes published in the *Records of the Indian Museum*. I have compared the larger specimen of *Sch. chrysochlora* with a specimen of the same size of *Sch. labiatus* with the following results:—

In *Sch. labiatus* the body is more slender and the head is considerably pointed; the labial fold is well-developed and prominently trilobed, the commencement of the dorsal fin is almost midway between the tip of the snout and the base of the caudal fin, and the anal scales are very small, considerably less than half the diameter of the eye. It is thus seen that the two species can be readily distinguished from each other.

Measurements in millimetres.[1]

Total length without caudal ...	94·5	177·0
Length of head	26·3	47·0
Height of head	15·0	29·6
Width of head	14·2	26·5
Length of snout	9·5	21·0
Diameter of eye	5·6	9·3
Interorbital distance ...	6·7	15·3
Depth of body	18·0	34·0
Longest ray of dorsal ...	17·4	32·0
Longest ray of anal ...	15·7	31·0
Length of pectoral... ...	18·2	34·3
Length of ventral	15·0	32·0
Length of caudal peduncle ...	16·0	30·8
Least height of caudal peduncle	9·0	16·0

Local name.—*Sch. chrysochlora* is locally known as *Sheer Māhī*, which literally means milk-fish or sweet-fish. It seems to be a common name for species of *Schizothorax* in Afghanistan, and in this reference is made probably to the taste of the flesh of these fishes.

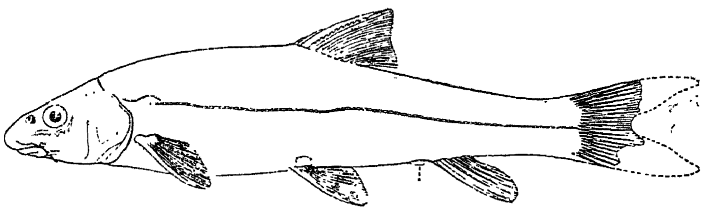
[1] On account of the protruded condition of the upper jaw and poor condition of preservation of the specimens, the measurements are likely to be faulty in certain cases, and should, therefore, be taken with considerable reserve.

Oreinus sinuatus var. **griffithii** McClelland

(Plate-fig. 3; text-fig. 3.)

1933. *Oreinus sinuatus* var. *griffithii*, Hora, *Journ. Bombay Nat. Hist. Soc.* xxxvi, p. 700.

In the collections of fish made in Afghanistan during 1933, there is a single specimen of the genus *Oreinus*, which I refer to *O. sinuatus* var. *griffithii*. The specimen was collected by Major A. E. Farwell at Sar-i-Chashma, the source of the Kabul river; it is 136·5 mm. in length without the caudal and is in a fine state of preservation. In my article[1] on the fish of Afghanistan, reasons were given for regarding the Kabul river form as distinct from *O. sinuatus*, though both are very much alike superficially. I have described this form in detail in my account of the fish of Chitral which will be published in the *Records of the Indian Museum*.



Text-fig. 3.—Lateral view of *Oreinus sinuatus* var. *griffithii* McClelland.

The following note from Griffith's observations is of special significance. Writing of the fish fauna of the Kabul river, he says: 'Towards its origin, and throughout the upper part of the Mydan Valley, a species of Oreinus is very abundant, numbers may be taken with a worm, the only instance I know of a fish with a Gonorhynchoid mouth taking bait. This same species swarms in the fine springs (from limestone) at Sar-i-Chashmah, which are the main source of the river; the fish are considered sacred, and appear to eat anything presented to them; the size does not exceed 5 lbs.'[2]

Alburnoides bipunctatus var. **eichwaldi** (Filippi).

1932. *Alburnoides bipunctatus eichwaldi*, Berg, *Poiss. des Eaux Douces U.R.S.S.*, i, p. 493 (see synonyms).

There is a single specimen, 74 mm. in length without the caudal, which I assign to *Alburnoides bipunctatus* var. *eichwaldi*. It was collected from the Margh river, a tributary of the Surkhab river. It has alrealy been indicated[3] that this is one of the species commonly found in the Upper Amudaria.

The fish is locally known as *Māhī putrā*.

[1] Hora, *Journ. Bombay Nat. Hist. Soc.*, xxxvi, p. 700 (1933).

[2] Griffith, *Calcutta Journ. Nat. Hist. Soc.*, ii, p. 564 (1842).

[3] Hora, *Journ. Bombay Nat. Hist. Soc.*, xxxvi, p. 706 (1933).

Barbus capito conocephalus Kessler × **Schizothorax** sp.

(Plate-figs. 5 & 6.)

In the small collection made by Capt. E. W. Fletcher in July 1933 from the Banu Anderab river, there is a small fish, 95 mm. in total length, which appears to be a hybrid between *Barbus capito conocephalus* and some species of *Schizothorax*. In general facies, it resembles the fishes of the subfamily *Schizothoracinae*, but possesses relatively larger scales. The lower jaw is bare anteriorly and the lip is somewhat papillated, so that the ventral surface of the head gives the appearance of a young *Oreinus*. A somewhat similar hybrid—*Barbus capito conocephalus* × *Schizothorax pseudaksaiensis issykkuli*—has been figured by Berg,[1] but, as compared with it, the head in the specimen under report is relatively short, high and much more rounded anteriorly. From the build of its head, it seems likely that the Afghanistan specimen is the result of crossing of the species of *Barbus* referred to above and *Schizothorax irregularis* (Berg, *Sch. intermedius irregularis*, *l.c.*, p. 460, fig. 385), but in the absence of sufficient material, it is not possible to be dogmatic about this suggestion. The interesting specimen is, however, described and figured here for future reference.

D. 3/8; A. 2/5; P. 15; V. 9; C. 20, besides smaller rays at the sides.

The specimen is subcylindrical with a short and rounded head. The ventral surface of the head is somewhat flattish and both the profiles are only slightly arched. The length of the head, of the caudal fin and the depth of the body are equal and are contained 5 times in the total length and 4 times in the length without the caudal. The width of the head is contained 1·6 times and the height of the head at the occiput 1·4 times in the length of the head. The eyes are large, dorso-lateral in position and hardly visible from the ventral surface; they are mostly situated in the anterior half of the head. The diameter of the eye is contained 3·8 times in the length of the head and 1·2 times in the length of the snout and the interorbital width. The nostrils are situated near the anterio-superior border of the eye. The mouth is transverse, semicircular and inferior; it is bordered by flat lips which are continuous at the angles of the mouth; the labial fold is interrupted in the middle; the flat, lower lip is finely papillated. The distal portion of the upper jaw is vertical and, when the mouth is closed, it lies in front of the lower jaw, which is hard, sharp and shovel-shaped for rasping purposes. A portion of the lower jaw is not covered by the lip anteriorly. There are two pairs of well-developed barbels, both longer than the diameter of the eye.

The base of the dorsal fin is midway between the anterior border of the eye and the base of the caudal fin; its longest ray is not as high as the depth of the body below it. The last spine is bony, but weak, and strongly denticulated posteriorly; there are about a dozen pair of teeth along the posterior border. The dorsal fin

[1] Berg, *Poisson des Eaux Douces U.R.S.S.*, 3rd ed., i, p. 450 (Leningrad: 1932).

commences considerably in advance of the ventrals. The pectoral fins are long and pointed, but do not extend as far as the base of the ventrals, which are similar to the pectorals and do not reach the anal-opening. The anal fin, when adpressed, does not reach the base of the caudal fin. The caudal fin is deeply forked and the lobes are sharp and pointed; the upper lobe is slightly longer than the lower. The caudal peduncle is 1·4 times as long as its least height.

The lateral line is complete and runs to the middle of the base of the caudal fin. The scales are small and imbricate. There are about 82 rows of scales in a longitudinal series, 14 between the lateral line and the commencement of the dorsal and 11 rows between the lateral line and the base of the ventral. There is a fleshy appendage in the axil of the pectoral fin, but none above the base of the ventral fin. The anal-opening and the anterior part of the base of the anal fin are provided with rows of somewhat larger scales. On the ventral surface the scales are embedded in the skin and there are only faint indications externally.

The colour is grayish above and pale-olivaceous below. The sides are marked with small, irregular patches of black colour which usually characterize the young *Schizothoracinae*.

Measurements in millimetres.

Total length including caudal	95·0
Length of caudal	19·0
Depth of body	19·0
Length of head	19·0
Width of head	11·8
Height of head at occiput	13·5
Length of snout	6·0
Diameter of eye	5·0
Interorbital width	6·0
Longest ray of dorsal	16·0
Longest ray of anal	13·0
Length of pectoral	16 0
Length of ventral	13·3
Length of caudal peduncle	14·0
Least height of caudal peduncle	9·8

GENUS: **Nemachilus** van Hasselt.

(Plate-figs. 1 & 2; text-fig. 4.)

The species of the genus *Nemachilus* are so numerous and the characters by which they are usually differentiated are so variable

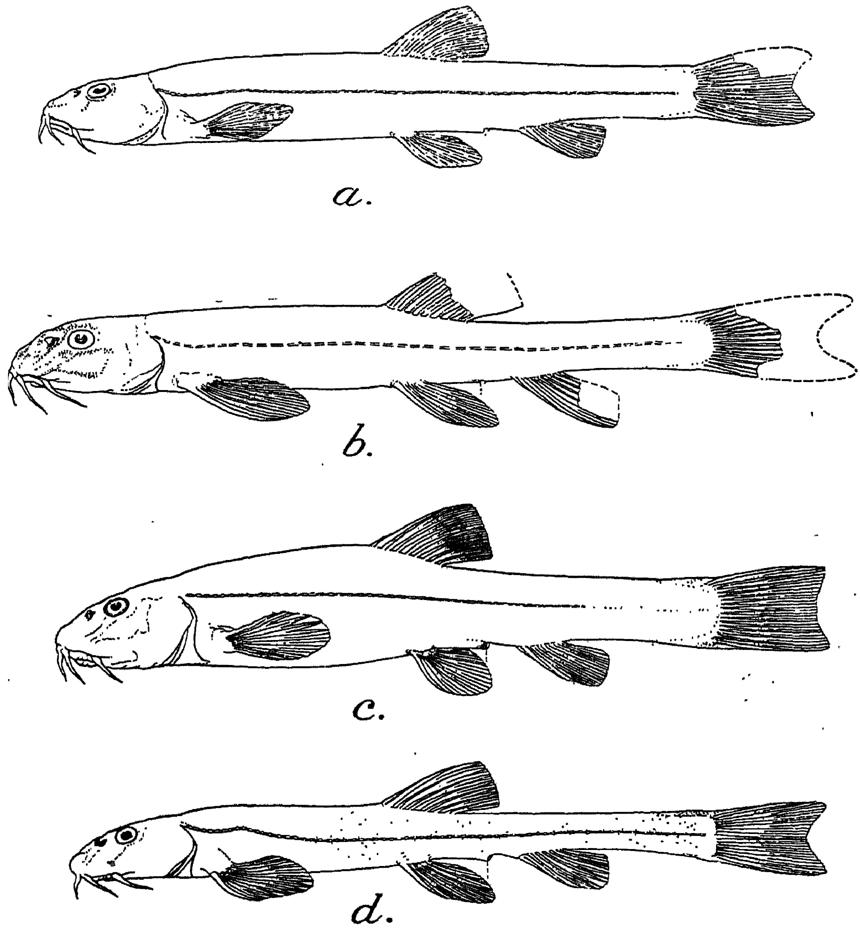
that considerable difficulty has often been experienced in separating one form from the other. This is specially so in the case of related species. The Nemachili from Afghanistan have hitherto proved to be a very confusing lot, but an attempt is made here to elucidate the precise limits of the various forms.

In 1929[1] attention was directed to the type material of two loaches from Afghanistan in the collection of the British Museum which had been erroneously stated to have come from 'Bhoutan' and 'Assam' in Günther's *Catalogue*.[2] Short notes were published then on the type specimens of *Adiposia boutanensis* (McClell.) and *Nemachilus griffithii* Günther, and their probable affinities were discussed. It was further stated that the former species was probably obtained in the Helmand basin near the Bolan Pass and the latter from the Arghandab river near Candahar. In 1933,[3] I assigned two specimens collected in the Paghman river, a tributary of the Kabul river near Kabul, to *N. griffithii* and published a detailed account with figures. It was indicated that the Paghman specimens differed from the typical examples in several important respects, but on account of the paucity of the material and the much smaller size of the fresh specimens, it was not considered advisable to propose a new name for them. In the collection under report, there are 23 specimens of the genus *Nemachilus*, 18 from the Helmand river basin and 5 from the Kabul river basin. Of the Kabul river specimens, 4 were obtained in the spring at Sar-i-Chashma and 1 in the Chahiltran stream; and these (text-fig. 4*c*) correspond in every respect with the specimens already reported from the Paghman river. It may be recalled that Griffith[4] observed a loach very common in the small channels by which the springs at Sar-i-Chashma run off. It is thus clear that in the Kabul river and its tributary streams, at least in the neighbourhood of Kabul, this particular type of loach is common, and as it differs in certain particulars from *N. griffithii*, I propose to treat it here as a separate variety which may be designated as **afghana.**

Through the kindness of Dr. C. Tate Regan and Mr. J. R. Norman, I have received on loan one of the two typical specimens of *N. griffithii* from the British Museum (Natural History). In forwarding the specimens Mr. Norman has observed that it 'differs somewhat from the other type in having a generally shorter and thicker body, shorter and less slender caudal peduncle and a rather larger head. We have little doubt, however, that in spite of these differences, the two types represent the same species'. The specimen (text-fig. 4*a*), which I have studied, is not in a good state of preservation, and is too flabby for accurate measurements. So far as it can be ascertained the length of the head is contained 4·7 times in the total length without the caudal, and the commencement of the dorsal

[1] Hora, *Journ. Proc. As. Soc. Bengal* (n.s.), xxiv, pp. 481-484, 1928 (1929).
[2] Günther, *Cat. Fish. Brit. Mus.*, vii, pp. 358, 360 (1868).
[3] Hora, *Journ. Bombay Nat. Hist. Soc.*, xxxvi, pp. 697-699, pl.-figs. 1 & 2 (1933).
[4] Griffith, *Calcutta Journ. Nat. Hist.*, ii, p. 564 (1842).

fin is nearer to the base of the caudal than to the tip of the snout. The distance between the pectoral and the ventral fins is about equal to the length of the pectoral. The least height of the caudal peduncle is contained 2·5 times in its length. The caudal peduncle



Text-fig. 4.—*Nemachilus* from Afghanistan.
Lateral view of (*a*) *Nemachilus griffithii* Günther, type-specimen $\times\frac{3}{4}$; (*b*) *Nemachilus griffithii* Günther, young specimen $\times 1\frac{1}{3}$; (*c*) *Nemachilus griffithii* var. *afghana*, nov., type-specimen $\times 1$; (*d*) *Nemachilus farwelli*, sp. nov., type-specimen $\times\frac{2}{3}$.

is muscular but is not much compressed from side to side. The diameter of the eye is contained 7·5 times in the length of the head, 3 times in the length of the snout and 1·5 times in the interorbital width. The snout is shorter than the postorbital part of the head. On comparing the above notes with the description of the species by Günther, two conclusions seem to be justified, (1) that Günther probably used the longer and narrower specimen for drawing up his description and (2) the species is subject to considerable vari-

ation in proportions, etc. It is for these reasons that I have still linked the Kabul river specimens with *N. griffithii.*

There are in the collection 17 specimens collected by Major A. E. Farwell in the Sar-i-Bulak stream, a tributary of the Helmand river, which appear to belong to *N. griffithii.* The specimens are young (Plate-fig. 1, and text-fig. 4*b*) and in all cases the fins are greatly damaged. However, in these examples the fins are relatively longer, the eyes are larger, the head is longer, and there are other points in which they differ from the typical examples, but, probably, all these differences are due to their juvenile state. It may, however, be indicated that these examples are very different from specimens of the same size of the form *afghana* referred to above from the Kabul river.

A fine specimen (plate-fig. 2 & text-fig. 4*d*) collected by Major A. E. Farwell in the Helmand river is so different in the form and shape of its caudal peduncle, general facies and proportions that it seems to represent a form hitherto undescribed. It is associated with the name of Major Farwell in slight recognition of the interest taken by the officers of the British Legation at Kabul in making known the ichthyology of this interesting region.

Nemachilus griffithii var. afghana, nov.

1933. *Nemachilus griffithii*, Hora, *Journ. Bombay Nat. Hist. Soc.* xxxvi, pp. 697-699, pl. i, figs. 1 & 2.

Major A. E. Farwell obtained 4 young specimens ranging in length from 54 mm. to 97 mm. including the caudal fin from the springs at Sar-i-Chashma, the source of the Kabul river. Griffith[1] remarked that 'In the small channels by which the springs run off, a loach is very common'. These specimens agree very closely with the examples described by me (1933) from the Paghman river. It has to be noted, however, that the latter were not well preserved and the swollen nature of the opercular region was a mere artifact. Both the lips are fleshy and plicated; the lower lip is very narrowly interrupted in the middle. The colour varies with the size of the specimens. Along the lateral line there is either a series of rounded spots, a moniliform band or a grayish streak. The caudal fin is more or less truncate and not emarginate.

A young specimen of the species was also collected by Sir Richard Maconachie in the Chahiltran stream, a tributary of the Kabul river about 6 miles to the west of the Kabul City.

Type-specimen.—No. F $\frac{11525}{1}$, *Zoological Survey of India, Indian Museum, Calcutta.*

Nemachilus farwelli, sp. nov.

(Pl.-fig. 2; text-fig. 4*d*.)

D. 2/7; A. 2/5; P. 1/11; V. 1/8; C. 16 (besides smaller rays at the sides).

[1] Griffith, *Calcutta Journ. Nat. Hist.*, ii, p. 564 (1842).

The new species of *Nemachilus*, which I have great pleasure in associating with the name of Major A. E. Farwell, Military Attaché to the British Legation at Kabul, has a very characteristic form. It is somewhat broad and depressed in the anterior region, but behind the dorsal fin it is greatly compressed from side to side. The tail portion is long and oar-like. All along the dorsal surface behind the head, the neural spines of the vertebrae form a prominent ridge. The following measurements give an idea of the form of the fish:—

	mm.
Height of head in the region of eyes	9·0
Height of head at occiput	10·6
Greatest height of body above middle of pectorals	12·7
Height of body at the commencement of dorsal fin	10·3
Height of body at the commencement of anal fin	7·8
Least height of caudal peduncle	6·8
Width of head in the region of eyes	11·7
Width of head in the opercular region ...	14·7
Width behind bases of pectorals	11·7
Width at the commencement of ventrals ...	6·5
Width at the commencement of anal	4·3
Least width of caudal peduncle	1·6

The dorsal profile is slightly arched, but the ventral profile is straight and horizontal throughout. The ventral surface is flattish and the paired fins are horizontally placed.

The head is depressed on both the dorsal and ventral surfaces; its length is contained 6·1 times in the total length with the caudal and 5·1 times without the caudal. The width of the head is contained 1·5 times and its height 2·1 times in its length. The snout is almost equal to the height of the head at the occiput. The eye is dorso-lateral in position and is not visible from the ventral surface; its diameter is contained 5·3 times in the length of the head, 2·4 times in the length of the snout, and 1·3 times in the interorbital width. The interorbital arc is almost flat. The nostrils are well developed and are situated much nearer the eye than the tip of the snout. The dorsal surface of the head is marked with series of lateral line organs which will be described below. The mouth is inferior, transverse and crescentic; it is situated considerably behind the tip of the snout and is co-extensive with the width of the head. The lips are well developed, fleshy and continuous at the angles; the lower lip is narrowly interrupted in the middle line. Both the lips are greatly fimbriated; the lower lip leaves the

jaw bare anteriorly. Both the jaws are strong and well developed; the anterior jaw lies in front and forms a hood-like covering over the posterior jaw which is provided with a sharp, rasping edge and is shovel-like. There are 6 barbels which are longer than the diameter of the eye; the maxillary barbels are the longest, but they are considerably shorter than half the length of the head. The gill-opening is lateral, extending for a short distance only on the ventral surface.

The body is smooth and devoid of scales; its greatest depth is contained 11 times in the total length with the caudal and 9·2 times without it. The lateral line is complete and forms a ridge-like prominence on the body. The lateral lines of the two sides are united dorsally by a transverse series of perforations along the posterior border of the head. Each lateral line is continued forwards to the middle of the eye where it is divided into two branches, the dorsal reaches the nostrils, while the ventral branch extends as far forwards as the angle of the mouth.

The dorsal fin commences slightly in advance of the ventrals, and its longest ray is considerably greater than the depth of the body below it. The commencement of the dorsal is nearer tip of snout than base of caudal; its free end is truncate. The pectorals are broad and horizontal in position; they are somewhat shorter than the head and are separated from the ventrals by a considerable distance. The ventrals are long and pointed, and extend beyond the anal opening, but do not reach the base of the anal fin; they are slightly shorter than the pectorals. The anal fin is similar to the dorsal. The caudal fin is almost as long as the head and is slightly emarginate. The caudal peduncle is oar-like; it is about 4 times as long as its least height.

The anal-opening is preceded by a tube in which there is a papilla-like structure. Between the anus and the anal fin there is a well-defined, narrow groove with raised margins. It is not possible to give the function of this structure which is very characteristic of the species.

The colouration in the spirit specimen is almost black along the dorsal surface and dirty white on the ventral surface. There are few indications of regular spots on the body below the lateral line. The dorsal and the caudal fins are marked with several indistinct bands and the other fins are also provided with a few irregular colour patches.

Locality.—Helmand river, Afghanistan.

Type-specimen.—No. F $\frac{11515}{1}$, *Zoological Survey of India, Indian Museum, Calcutta.*

Remarks.—In general facies *Nemachilus farwelli* is remarkable, and though I have handled big collections of Nemachili, I have not come across any form approaching it in the shape of its caudal peduncle. The position of the dorsal fin and the nature of its lips are other distinguishing characters. The well-marked groove between the anus and the anal fin is also characteristic of the species. *Nemachilus farwelli* has no resemblance to the species of

Adiposia[1] *A. macmahoni* (Chaudhuri), *A. rhadinaea* (Regan) and *A. boutanensis* (McClelland)—known from the lower reaches of the Helmand system. *N. tenuis* Day, which has been recorded from the Helmand river,[2] possesses a rounded, slender and long caudal peduncle.

Measurements in millimetres.

Total length including caudal	140·0
Length of caudal ...	22·0
Depth of body	12·7
Length of head ...	22·8
Length of snout ...	10·5
Interorbital width ...	5·5
Diameter of eye ...	4·3
Width of head	14·7
Height of head at occiput ...	10·6
Longest ray of dorsal ...	20·8
Length of pectoral ...	20·0
Length of ventral ...	19·0
Longest ray of anal ...	18·0
Length of caudal peduncle	27·2
Least height of caudal peduncle	6·8

[1] Annandale & Hora, *Rec. Ind. Mus.*, xviii, pp. 182-190, text-figs. 10, 12-15, pl. xv, fig. 4; pl. xvi, figs. 1 & 2 (1920); Hora, *Journ. As. Soc. Bengal* (n.s.), xxiv, pp. 481, 482, fig. 1 (1929).

[2] Hora, *Rec. Ind. Mus.*, xxiv, p. 77 (1922).

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INDIAN MUSEUM

Vol. XXXVIII, Part I, pp. 1—7

Notes on Fishes in the Indian Museum. XXVI. On a small collection of Fish from the Chitaldrug District, Mysore.

By

SUNDER LAL HORA

CALCUTTA:

MARCH, 1936

NOTES ON FISHES IN THE INDIAN MUSEUM.

XXVI.—On a small collection of Fish from the Chitaldrug District, Mysore.

By Sunder Lal Hora, *D.Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.*

While engaged in a general study of the flora and fauna of the step-wells in the Chitaldrug District, Mysore, in connection with investigations on the biological method of control of dracontiasis, Dr. V. N. Moorthy made a small collection of fish which he sent to the Zoological Survey of India for identification. It contained 185 specimens belonging to the following 16 species :—

1. *Mystus cavasius* (Ham.) . .	1 specimen.
2. *Cirrhina fulungee* (Sykes) . .	1 specimen.
3. *Barbus sarana* (Ham.) . .	1 specimen.
4. *Barbus* (*Puntius*) *sophore* (Ham.)	8 specimens.
5. *Barbus* (*Puntius*) *chola* (Ham.) .	2 specimens.
6. *Barbus* (*Puntius*) *dorsalis* (Jerdon)	74 specimens.
7. *Barbus* (*Puntius*) *ticto* (Ham.) .	15 specimens.
8. *Barbus* (*Puntius*) *parrah* Day .	3 specimens.
9. *Rasbora daniconius* (Ham.). .	20 specimens.
10. *Danio malabaricus* (Jerdon) .	5 specimens.
11. *Chela clupeoides* (Bloch.) . .	3 specimens.
12. *Nemachilus denisonii* Day . .	5 specimens.
13. *Lepidocephalichthys thermalis* (C. V.)	27 specimens.
14. *Panchax lineatum* C. V. . .	5 specimens.
15. *Mastacembelus pancalus* (Ham.) .	2 specimens.
16. *Ophicephalus gachua* Ham. .	13 specimens.

Dr. Moorthy observes that *B. dorsalis, B. ticto, R. daniconius* and *L. thermalis* are the species that have proved useful in guinea-worm control measures. With the exception of *Mystus cavasius, Cirrhina fulungee, Barbus sarana, Mastacembelus pancalus* and *Ophicephalus gachua,* which grow to a fairly big size, all the other smaller species should prove helpful in the biological control of the guinea-worm disease. It should be noted, however, that in the step-wells of the Chitaldrug District *B. dorsalis* is commonly met with—it was collected at 19 of the 38 localities investigated—and as the species has already proved useful, its cultivation for stocking other pieces of water should be encouraged.

In 1927, Narayan Rao and Seshachar [1] published a list of the fresh-water fishes of Mysore. In Dr. Moorthy's collection there are specimens of the following six species, *viz., Cirrhina fulungee* (Sykes), *B.* (*Puntius*) *chola* (Ham.), *B.* (*Puntius*) *sophore* (Ham.), *B.* (*Puntius*) *dorsalis* (Jerdon), *B.* (*Puntius*) *ticto* (Ham.), and *Danio malabaricus* (Jerdon), which are not included in that list.

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[1] Narayan Rao and Seshachar, *Half-yearly Journ. Mysore University* I, No. 2, pp. 1-29 (1927).

The study of the material collected by Dr. Moorthy has enabled me to show that *Leuciscus binotatus* Blyth[1] and *Puntius* (*Capoeta*) *puckelli* Day [2] are juvenile forms of *Systomus dorsalis* Jerdon [3]. It is also clear that *Barbus tetraspilus* Günther [4] is a synonym of *B. dorsalis* (Jerdon). So far as I am aware, *Cirrhina fulungee* (Sykes) [5] is a very rare species in museum collections and its specific limits are not properly defined. I, therefore, give below a description of a fresh specimen of *Cirrhina fulungee* (Sykes) and also discuss briefly the synonymy of *Barbus* (*Puntius*) *dorsalis* (Jerdon).

Barbus (Puntius) dorsalis (Jerdon).

1849. *Systomus dorsalis*, Jerdon, *Madras Journ. Lit. & Sci.*, XV, p. 314.
1858. *Leuciscus binotatus*, Blyth, *Journ. As. Soc. Bengal*, XXVII, p. 290.
1868. *Barbus dorsalis*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 142.
1868. *Barbus tetraspilus*, Günther, *ibid.*, p. 142.
1868. *Puntius* (*Capoeta*) *Puckelli*, Day, *Proc. Zool. Soc. London*, p. 197.
1878. *Barbus dorsalis*, Day, *Fish. India*, p. 573, pl. cxlii, fig. 2.
1878. *Barbus Puckelli*, Day, *ibid.*, p. 574, pl. cxliii, fig. 5.
1889. *Barbus dorsalis*, Day, *Faun. Brit. Ind. Fish.*, I, p. 319.
1889. *Barbus puckelli*, Day, *ibid.*, p. 321.
1911. *Barbus dorsalis*, Willey, *Spolia Zeylanica*, VII, p. 103.
1916. *Barbus dorsalis*, Raj, *Rec. Ind. Mus.*, XII, p. 255.
1930. *Puntius dorsalis*, Deraniyagala, *Spolia Zeylanica*, XVI, p. 12.

In 1849, Jerdon described a small species of *Barbus* under the name *Systomus dorsalis* from "the tanks and rivers in the neighbourhood of Madras" and characterised it as follows:—

"Head is 3½ times in total length; height is 3 times in the same; snout irregular; 26 scales along the sides in 8 rows; 2 labial cirri; profile rising to dorsal and descending rapidly to the end of that fin; thence nearly straight; bluish above, yellowish on the sides, silvery beneath, a black spot on each side of the tail occasionally; fins with a yellowish tinge; D. 3-8, A.7, etc. Dorsal fin with a black spot on its base behind; 4 to 5 inches long."

B. dorsalis is a well known South Indian fish and, according to Day (1878), it is found in "Kurnool, Mysore, throughout Madras as low as the Cauvery and Coleroon rivers and Ceylon." In Dr. Moorthy's collection there are several young, half-grown and adult specimens of *B. dorsalis*. The colouration of the species differs at various stages of its growth. Further, in the young the last dorsal spine is weak and flexible but in specimens over four inches in length it becomes hard and bony. In differentiating small species of *Barbus*, considerable reliance is placed on the structure of the last dorsal spine and on the nature of the colour markings and it is no wonder, therefore, that *B. dorsalis* has been described under different names at various stages of its growth.

In very young specimens about 23 mm. in total length (text-fig. 1*a*) there is a deep, black spot on the basal portion of the posterior dorsal rays, a second similar spot at the centre of the base of the caudal fin on each side and a smaller spot at the base of the posterior anal rays

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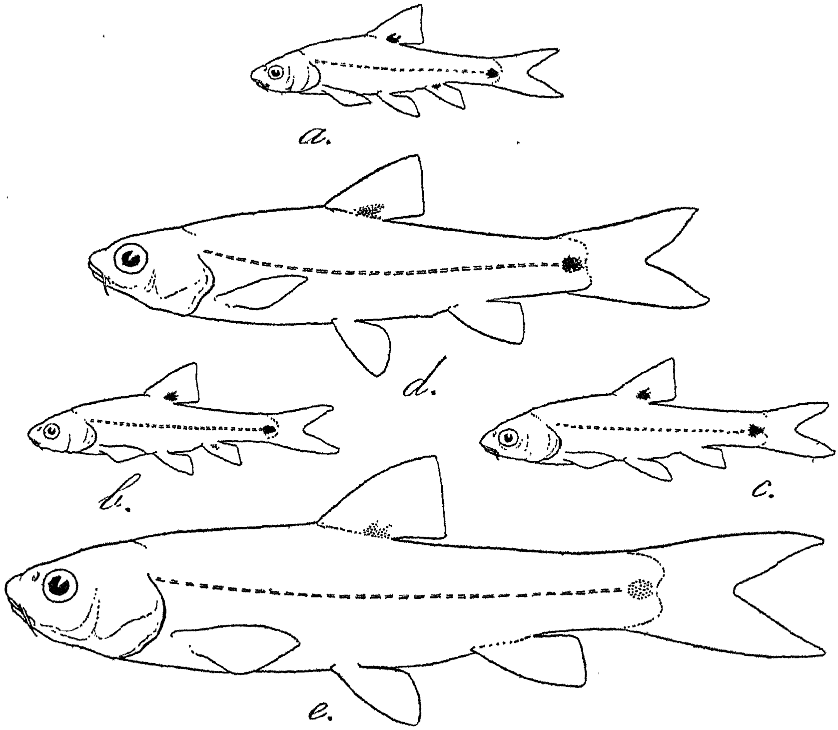
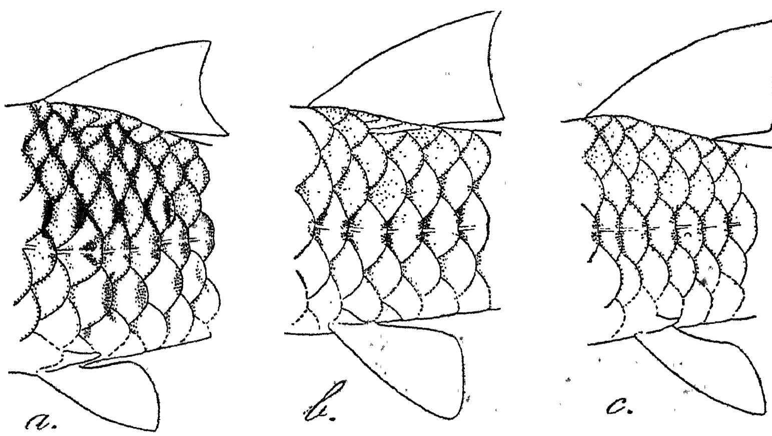
[1] Blyth, *Journ. As. Soc. Bengal*, XXVII, p. 290 (1858).
[2] Day, *Proc. Zool. Soc. London*, p. 197 (1868).
[3] Jerdon, *Madras Journ. Lit. & Sci.*, XV, p. 314 (1849).
[4] Günther, *Cat. Fish. Brit. Mus.*, VII, p. 142 (1868).
[5] Skyes, *Trans. Zool. Soc. London*, II, p. 358 (1841).

The bases and margins of the scales, especially in the dorsal region, are covered with minute, irregularly scattered, small, black dots (text-



Text-fig. 1.—Growth stages of *Barbus* (*Puntius*) *dorsalis* (Jerdon), showing the gradual disappearance of anal, dorsal and caudal spots. × *ca.* $1\frac{1}{3}$.



Text-fig. 2.—Portion of body in the region of dorsal fin, showing gradual appearance of colour markings on scales in three growth stages of *Barbus* (*Puntius*) *dorsalis* (Jerdon).

a. From a specimen 144 mm. in total length. × $\frac{7}{8}$.
b. " " 63 " " × $2\frac{5}{8}$.
c. " " 34 " " × $4\frac{1}{2}$.

fig. 2*c*). The last dorsal spine is very weak at this stage. With the growth of the fish, the anal spot disappears (text-fig. 1,*b* and *c*), the markings on the scales become more prominent (text-fig. 2*b*) while the dorsal and the caudal spots persist in a fairly well-marked condition in specimens up to 83 mm. in length, though they are sometimes reduced and become lighter in colour (text-fig. 1,*d* and *e*). The dorsal spine is still very weak.

Attention may be directed here to *Barbus puckelli* (Day) described from a single specimen, 3 inches long, collected at Bangalore. The species is characterised, among other peculiarities, by the presence of a "deep-black mark on the dorsal fin from the base of the third to the base of the sixth branched ray. Very fine dark dots over scales, especially at their bases. An indistinct black mark on lateral line from nineteenth to twenty-first scale." No other author seems to have recorded this species though it is stated by Day (1878) to be very common at Bangalore. I have several examples in Dr. Moorthy's collection which agree with Day's description in almost every respect, but from the series of specimens before me it is certain that *B. puckelli* is only a juvenile form of *B. dorsalis*. A very characteristic feature of the species at this stage is, as already noted by Day, that the extremity of the lower jaw is not covered by the lip.

In describing the colouration of the Ceylonese specimens of *Puntius dorsalis*, Deraniyagala says that "In immature specimens from localities such as Jaffna, Mankulam (N. P.) and Kahavatta (Sab. P.) there is a well marked lateral band extending from the shoulder along the lateral line to the caudal blotch; while the posterior half of the basal sheath of the dorsal is also black, and often the upper and lower margins of the caudal are dark. These marks usually persist until the fish is 90 mm. long".

The description of the colour of *Leuciscus binotatus* Blyth, based on a specimen 1·5 inches in length from Ceylon, agrees with what is stated above by Deraniyagala and there seems to me no doubt that Blyth's species has also to be regarded as a juvenile form of *B. dorsalis*.

In Indian specimens there is no lateral band and the margins of the caudal fin are not stained black.

Under the synonomy of *B. dorsalis*, Day (1878) included *Systomus tristis* Jerdon, with a querry, *B. tetraspilus* Günther and *B. layardi* Günther. He, however, remarked that "*B. tetraspilus* differs from *B. dorsalis* in having a dark spot before the base of the caudal fin". As regards the persistence of caudal and dorsal spots, it may be noted that in specimens up to 80 mm. the former is sometimes fainter than the latter (text-fig. 1*d*) or *vice versâ*, but on the whole the caudal spot disappears earlier. In an old specimen from Day's collection 117 mm. in total length, there is an indication of the dorsal spot whereas the caudal spot is altogether faded. In describing *B. tetraspilus*, Günther had one adult, 7·5 inches in length, and one young specimen before him. There can be no doubt that his young specimen had the spots prominently marked, while they may have been faintly represented in the adult I agree with Day in regarding *B. tetraspilus* as a synonym of *B. dorsalis*

B. layardi Günther lacks all the colour markings of *B. dorsalis* and besides has only 23 scales along the lateral line. I have examined a specimen of *B. dorsalis*, 142 mm. in total length, in which though the dorsal and the caudal spots are absent, but the black markings at the bases of the scales are very prominent (text-fig. 2*a*). Without an examination of the types, it is very difficult to be certain about the systematic position of *B. layardi*, but I am inclined to regard it, for the time being, as a distinct species.

The description of *Systomus tristis* Jerdon is inadequate for judging its precise specific limits. The species was based on a single specimen, 3 inches long. In the description of its colour there is neither any reference to the characteristic dorsal and caudal spots, nor to the markings on the scales. In all probability, *B. tristis* is not conspecific with *B. dorsalis*.

According to Willey's [1] observations the spawning season of *B. dorsalis* in Ceylon is about August, but Dr. Moorthy collected a large number of young specimens during March and April.

Cirrhina fulungee (Sykes).

1841. *Chondrostoma Fulungee*, Sykes, *Trans. Zool. Soc. London*, II, p. 358.
1868. *Gymnostomus fulungee*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 76.
1878. *Cirrhina fulungee*, Day, *Fish. India*, p. 549, pl. cxxxii, fig. 1.
1889. *Cirrhina fulungee*, Day, *Faun. Brit. Ind. Fish.*, II, p. 280.

In describing *Chondrostoma fulungee*, Sykes indicated that the species "would be referred to Dr. Hamilton's third subgenus of *Cyprinus* "*Bangana*", but it is not to be identified with any of the species, although in outline it has a close resemblance to the figure of *Cyprinus Mrigala*, and has other general points of resemblance". Unfortunately the species was not illustrated and, judged by modern standards, the description is very inadequate. Günther included this species in the composite genus *Gymnostomus* and made no reference to its distinguishing features. Day recognised the species but remarked that "*Cirrhina fulungee*, Sykes, is very closely allied to *C. mrigala*, but its barbels are shorter". In making this statement Day seems to have been influenced by the observations of Sykes, for even according to Day's descrptions the two species differ in *lepidosis* and in the number of branched rays in the dorsal fin (12 to 13 in *C. mrigala* and 8 in. *C. fulungee*). There are in addition marked differences in the body proportions also.

The original of Day's description and figure in the *Fishes of India* is now preserved in the collection of the Indian Museum; it is 92 mm. in total length without the caudal and is in a tolerably good state of preservation. The locality label is faded but with proper illumination and magnification the locality can be made out as "Poonna". In the fish register of presentations to the Indian Museum it is numbered 2360 and is noted to have been purchased from Day in 1879; but its locality is given as "Burma". This is obviously wrong for Day never had a specimen of this species from Burma. In fact, it seems probable that Day had examined only one specimen of the species which is now preserved in the Indian Museum.

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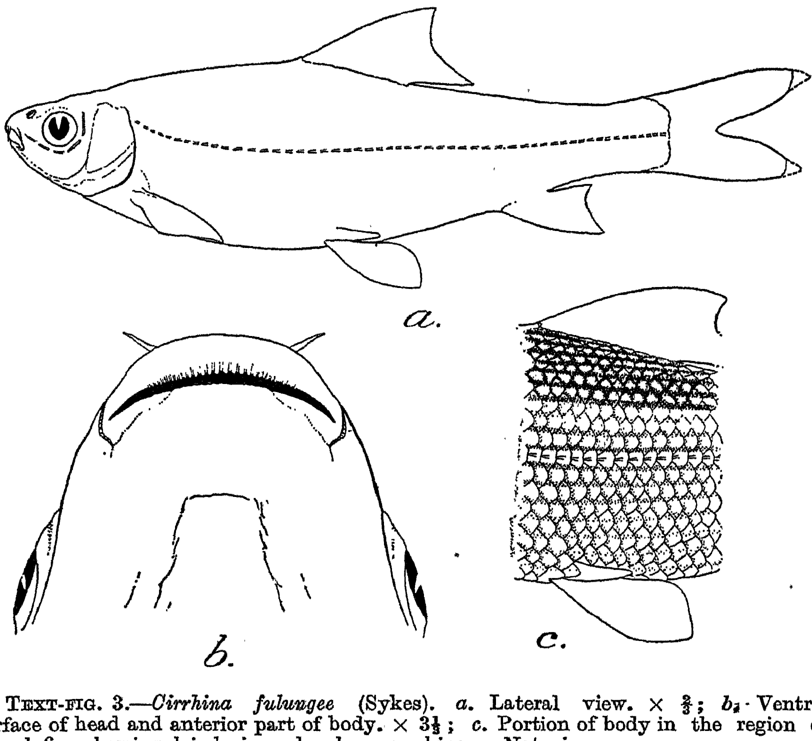
[1] Willey, *Spolia Zeylanica*, VII, p. 103 (1911).

In Dr. Moorthy's collection there is a fully mature female specimen with ripe gonads; it is 123 mm. in total length without the caudal and on account of its large size it differs in proportions from the specimen described by Day. It may be described as follows:—

D. 3/8; A. 3/5; P. 15; V. 9; C. 19; L. I. 53.

The dorsal profile is slightly convex but the ventral profile is greatly arched. The body is deepest between the commencements of the dorsal and ventral fins and thence it tapers towards both ends. The head is small and bluntly pointed; its length is contained 4·8 times in the total length without the caudal. The width of the head is contained 1·3 times and height of the head 1·1 times in its length. The eyes are lateral and are situated mostly in the anterior half of the head; the diameter of the eye is contained 3·6 times in the length of the head, 1·2 times in the length of the snout and 1·8 times in the interorbital width. The



TEXT-FIG. 3.—*Cirrhina fulungee* (Sykes). *a.* Lateral view. × $\frac{2}{3}$; *b.* Ventral surface of head and anterior part of body. × $3\frac{1}{3}$; *c.* Portion of body in the region of dorsal fin, showing leipdosis and colour markings. Nat. size.

interorbital space is slightly convex. There is only one pair of small rostral barbels which are about one-third the diameter of the eye. The mouth is distinctly inferior and is overhung by a rostral fold which is slightly fimbriated. The two lips are continuous at the angles. The lower lip is free from the jaw anteriorly; the lower jaw has a sharp margin. There are shallow grooves at the sides of the snout which commence round the angles of the mouth.

The depth of the body is contained 3·6 times in the total length without the caudal. The scales are small but firmly set; there are 53 scales along the lateral line, which is complete, 10 transverse series of scales between the lateral line and the commencement of the dorsal and 6½ series between the former and the base of the ventral fin. There are 17 predorsal scales and about 22-23 scales round the caudal peduncle. There are well-developed scaly sheaths in the axils of the ventral fins. The least height of the caudal peduncle is contained 1·8 times in its length.

The commencement of the dorsal fin is slightly in advance of that of the ventral and is much nearer to the tip of the snout than to the base of the caudal; the free border of the fin is concave and its longest ray is almost equal to the length of the head and considerably shorter than the depth of the body below it. The anal fin is similar to the dorsal in form but it is much shorter. The pectoral fins are pointed in the middle and are shorter than the head; they are separated from the ventrals by a distance equal to their length. The ventral fins are not so pointed as the pectorals and, when spread out, appear rounded; they are separated from the anal opening by a distance equal to the postorbital part of the head. The caudal fin is deeply bifurcate and has pointed lobes.

The colouration is spirit in dark above and very pale olivaceous below. The borders of the scales are marked with fine black spots and the general impression they give is that the body is marked with a series of longitudinal bands. The dorsal fin and the basal half of the caudal fin is gray.

Dr. Moorthy has kindly presented this specimen[1] to the Zoological Survey of India.

Measurements in millimetres.

Total length excluding caudal	123·0
Depth of body .	36·0
Length of head .	25·5
Width of head .	19·5
Height of head .	22·4
Length of snout .	8·5
Diameter of eye .	7·0
Interorbital width .	12·5
Length of rostral barbel	2·5
Longest ray of dorsal	26·0
Longest ray of anal .	18·8
Length of pectoral .	21·0
Length of ventral .	20·0
Length of caudal peduncle	22·0
Least height of caudal peduncle	14·0

[1] Dr. Moorthy has since sent 3 more s

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PROCEEDINGS
OF THE
NATIONAL INSTITUTE OF SCIENCES OF INDIA
Vol. II, No. 1, pp. 45–47

NATURE OF SUBSTRATUM AS AN IMPORTANT FACTOR IN THE ECOLOGY OF TORRENTIAL FAUNA

By
S. L. HORA

Calcutta:
1936

8-4-1936

NATURE OF SUBSTRATUM AS AN IMPORTANT FACTOR IN THE ECOLOGY OF TORRENTIAL FAUNA.

By SUNDER LAL HORA, *D.Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.*

(*Read January* 4, 1936.)

In studying the ecology of the torrential fauna attention has so far been paid to the physico-chemical composition of the water (Hubault, 1927) or to the mechanical effects of the swift currents (Hora, 1930). In the course of my recent investigations another important factor—nature of substratum—has, however, appeared very potent in the distribution of certain types of animals. While grouping the torrential population into two sub-associations, namely, the plant-inhabiting animals and the rock-inhabiting animals, attention was directed (Hora, 1930, p. 177) to the fact that the distribution of the fauna is influenced by the nature of the bed. As an example, it was indicated that the occurrence of the Blepharocerid larvæ and the nymphs of *Iron* in the Pun-Wa-Sherra Stream could be correlated with the bare and smooth rocks in its bed, whereas their absence from the Dhud-Dhara fall was due to the thick growth of moss on the rocks. Both types of insect larvæ referred to above adhere by means of complete or partial suckers which can only function on smooth rocks, and this fact has an important bearing on the distribution of these animals.

While specially looking for Blepharocerid larvæ in suitable places during a recent visit to the Mussoorie Hills, the insects were found plentiful in certain streams while they were totally absent from others. Superficially all the streams appeared alike and the physical conditions seemed favourable for the occurrence of the Blephorocerid larvæ (Hora, 1931). The fauna of the Mossy Falls was investigated first and a large number of Blepharocerid larvæ were collected. Next a visit was paid to the Bhatta Falls but not a single Blepharocerid larva or pupa was found in this stream though there was no growth of moss on the rocks. In suitable places, however, there was a rich growth of long, filamentous algæ. On a closer examination of the problem, it was noticed that the rocks of the Bhatta Falls were covered with a deposition of lime which rendered the surface uneven and porous. Such a surface is certainly inimical to the occurrence of animals that use suckers for stemming strong currents, and is suitable for the growth of filamentous algæ. The rocks of the Mossy Falls, on the other hand, were smooth and did not harbour filamentous algæ.

Bearing this explanation in mind, several other streams were investigated and it was found that streams below Barlowganj had smooth rocks and were

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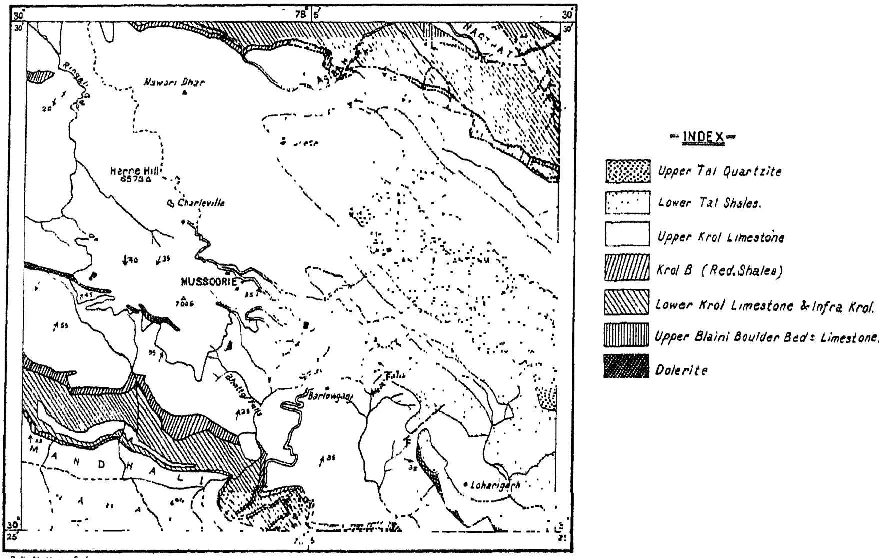
[Published April 8th, 1936.

full of Blepharocerid larvæ in suitable places. At the Kamti Falls the nature of the bed was similar to that of the Bhatta Falls and in consequence no Blepharocerid larvæ were found in this stream. In the case of the Sansa Dhara stream, about 3 miles from Rajpur, Blepharocerid larvæ were found on smooth rocks while they were absent on adjacent rocks that had a pitted surface. These observations clearly show that the nature of the bed is an important ecological factor in the distribution of the Blepharoceridæ.



S K Mallick Del GEOLOGICAL MAP OF MUSSOORIE. BY J. B. AUDEN.

On my return to Calcutta, reference was made to the Geological Survey of India regarding the differences in the nature of beds of the various streams investigated. Mr. J. B. Auden, who has studied the geology of this area in recent years, has found that the differences are due to the geological formation of the rocks over which the streams flow. My conclusions regarding the distribution of the Blepharoceridæ from field observations are fully borne out by the geological data presented below by Mr. Auden. He states that

'Mussoorie and Landour are situated at the north-west end of a syncline of Krol and Tal rocks. The Upper Krol stage of the Krol series consists of dolomitic and calcitic limestones interbedded with shales. In contrast to the dominantly calcareous nature of the Upper Krols, the Lower Tal stage is made up almost entirely of dark micaceous shales, while the Upper Tal stage consists of quartzites. Limestones are almost entirely absent from the Tals.

Waters arising from springs in the Krol limestones are hard. Aeration of such waters leads to the decomposition of the unstable bicarbonate and the precipitation of the lime in the form of a rough and porous tufa, such as is seen on the Bhatta and Kampti falls. The water descending the Mossy falls is derived, on the other hand, from the Lower Tal shales which crop out on the Wellington ridge, and is consequently soft. It is true that, after leaving the shales, the water flows over the underlying Krol limestones, but the steepness of the descent and the certainty therefore of aeration is likely to prevent any

precipitation of tufa by inhibiting the initial solution of lime. Differences in the nature of the waters arising from springs situated entirely within the Krol limestones may be explained perhaps by the greater degree of solubility of the calcitic limestones compared with those that are dolomitic.

In addition to the chemical difference mentioned above there are physical differences between the Krol and Tal rocks. The Upper Krol limestones weather into rough boulders, while the Lower Tal shales are worn down by streams into smooth pebbles. The smoothness of these pebbles is probably in itself inimical to the deposition of lime, even were such present in the water as bicarbonate, while the rougher limestone boulders tend to favour the deposition of lime by virtue of the stirring up of the water flowing over them.'

The conditions presented by the Song River and Ray Nadi near Lachhiwala, about 11 miles from Dehra Dun, were quite different. The rocks forming the bed were smooth and there was no deposition of lime anywhere ; they were, however, covered with a very slippery growth of algal matter and in consequence not bare. The Blepharocerid larvæ were absent from these streams also, and it appears obvious that they occur only in such places where their suckers can function.

The observations recorded above show that the rocks of a torrential stream can be rendered unsuitable for the existence of the Blepharoceridæ if there is (i) rich growth of moss, (ii) deposition of lime, or (iii) slippery growth of algæ on them. The other conditions may appear very favourable, but if the rocks are not bare and smooth the Blepharocerid larvæ cannot live on them on account of physical reasons.

Such observations lead to the conclusion that in the study of 'Adaptations' it is absolutely essential to examine in detail all the factors in an environment, otherwise, on a superficial examination, one is liable to believe that there is no correlation between a habitat and the fauna it supports.

In the end I have to thank Mr. J. B. Auden for his kindness in supplying a geological map and a short geological account of the area zoologically investigated by me.

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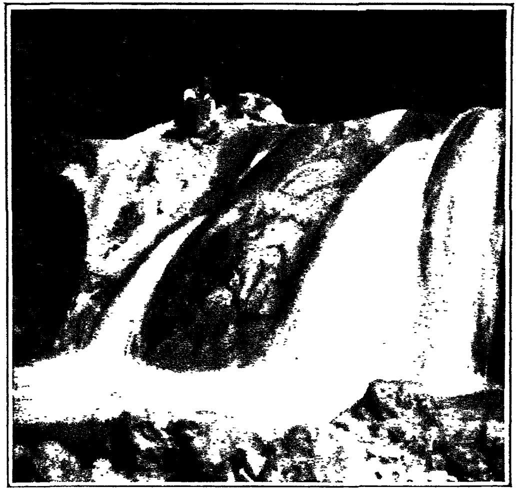
CALCUTTA:—Published by the National Institute of Sciences of India, 1, Park Street, and Printed by P. Knight, Baptist Mission Press, 41A, Lower Circular Road.



D. D. Mukerji, Photo.

Bhatta Falls, Mussoorie.

Stream below Barlowganj.

The two photographs illustrate a similar type of environment, but the fauna in the two streams was different, owing to the fact that the rocks of the Bhatta Falls were covered with rough and porous tufa, while those of the stream below Barlowganj were smooth.

ARTICLE XVII

REPORT ON FISHES. PART I: COBITIDAE[1]

By Sunder Lal Hora, D.Sc., F.R.S.E., F.A.S.B.

Zoological Survey of India, Calcutta

(Received August 16, 1935)

CONTENTS

INTRODUCTION

Mr. G. E. Hutchinson, biologist to the Yale North India Expedition, entrusted to me an extensive and interesting collection of fishes for study and report in October 1933, but it was not possible to take up the work till the later part of 1934. The collection was made in the Kashmir Valley and Ladakh, and comprises representatives of *Sisoridae* (*Glyptothorax* and *Glyptosternum*), Cyprininae (*Labeo* and *Crossocheilus*), *Schizothoracinae* (*Schizothorax*, *Ptychobarbus*, *Schizopygopsis*, *Diptychus* and *Orcinus*) and *Cobitidae* (*Botia* and *Nemachilus*). As was to be expected, *Glyptothorax*, *Labeo*, *Crossocheilus* and *Botia* were found only in the Kashmir Valley, while *Nemachilus* and the *Schizothoracinae* were equally abundant at high altitudes and in the Valley. In this article, I propose to deal with the *Cobitidae*, especially the genus *Nemachilus*, which in the lakes and torrential streams of Central Asia has proliferated into many species showing diverse structural, adaptive modifications. The present collection contains one species of *Botia* and eight species of *Nemachilus*.

I take this opportunity to offer my sincere thanks to Mr. Hutchinson for affording me an opportunity to investigate this interesting material and for his invaluable field notes. I am indebted to the authorities of the Yale North India Expedition for a grant towards the cost of drawings which were executed by Babu R. Bagchi under my supervision.

[1] Published with permission of the Director, Zoological Survey of India.

ECOLOGY AND STRUCTURAL MODIFICATIONS

Ecologically, the eight species of the genus *Nemachilus* represented in the collection of the Yale North India Expedition may be divided into three "associations": (i) Bottom-dwelling species of the lakes, such as *N. vittatus*, which live in 4 to 6 feet of water but probably rise from the bottom occasionally and swim about ; (ii) bottom-dwelling species in torrential streams, such as *N. stoliczkae, N. gracilis, N. microps* and *N. tenuicauda*, which habitually live adhering to rocks and stones in swift currents though at times, especially during the breeding season, may enter into springs, pools and lakes; (iii) free-swimming lake species, such as **N. deTerrai, N. hutchinsoni** and **N. panguri**, which swim about freely in still waters but for feeding purposes have to cling to rocks and other objects, usually at the bottom. Correlated with the above differences in habits and habitats, the species have undergone remarkable modifications in the structure of certain organs.

Air-bladder. In 1930, I[2] referred to the modifications of the air-bladder in species of *Nemachilus* from several localities and indicated the close relation between its structure and the type of habitat in which the species lived. On account of the occurrence of gradations between the *Nemachilus*-type of bladder and the *Diplophysa*-type of bladder, it was indicated that the differences in the structure of the bladder could not be used for taxonomic purposes. Rendahl[3] has, however, used this character in proposing several sub-genera for the species of *Nemachilus* obtained by Dr. Sven Hedin in Central Asia, and has given a detailed morphological account of the modifications observed by him. The accompanying figure shows some of his illustrations and an attempt is made below to explain the possible significance of these modifications, as I interpret them.

The structure of the air-bladder of *N. barbatula* (Text-figure 1F) is characteristic of the species that live in swift currents and, though they may dart from place to place, are rarely seen to swim. In these circumstances, the air-bladder has lost its buoyant function and its anterior portion is represented by two small lateral chambers (*a*) enclosed in bony capsules and the posterior chamber by a small, thick-walled bag (*c*). This type of structure is found in *N. stoliczkae, N. gracilis, N. microps* and *N. tenuicauda.* In *N. yarkandensis* (Text-figure 1D) the form of the bladder remains the same but the lateral chambers are greatly enlarged so that they come in close contact with the skin. In the areas of contact, the bony capsules are incomplete so that the bladder can react to the surrounding changes in pressure. The structure of the bladder in *N. yarkandensis* is more or less similar to that of *N. vittatus* (Hora 1930, Text-figure 6*c*) and probably the habits and habitats of the former are similar to those of the latter. *N. vittatus* is a lake species and the Yale North India Expedition obtained several specimens, mostly from the weedy marginal areas of the Kashmir lakes. Probably the species lives at or near the bottom and does not swim about much. The Netherlands Karakorum Expedition obtained specimens of *N. yarkandensis* from pools in the neighbourhood of extensive marshes at Rabat-Utsang. The real lake forms that move about in all possible directions are characterised by a bladder of the type found in *N. stewarti* (Hora 1930, Text-figure 8), *N. hutjertjuensis* (Text-figure 1A) and three new species of *Nemachilus* described here from Western Tibet (Text-figures 5*b*, 7*b*, 9*b*). The posterior

[2] Hora, *Journ. Bombay Nat. Hist. Soc.* XXXIV, pp. 379-385 (1930).
[3] Rendahl, *Arkiv för Zoologi* XXV, No. 11, pp. 1-51 (1933).

chamber of the bladder has assumed the form of the typical Cyprinid bladder and probably functions in exactly the same way.

The type of bladder found in *N. kungessanus* (Text-figure 1B) shows that the species

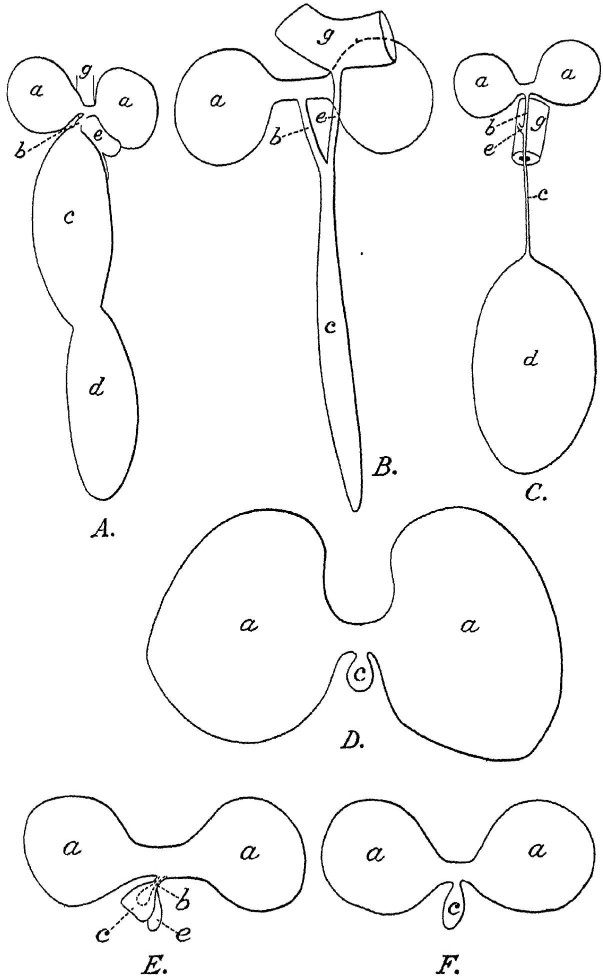


FIGURE 1. Various types of air-bladder found in *Nemachilus* (after Rendahl). Various magnified. A: *N. hutjertjuensis* Rend.; B: *N. kungessanus* (Kessl.); C: *N. papillo-labiatus* (Kessl.); D: *N. yarkandensis* Day; E: *N. hsutschouensis* Rend.; F: *N. barbatula* (Linn.). a = portion of bladder enclosed in bone; b = duct connecting the enclosed and the free portions of the air-bladder; c = anterior chamber of the free portion of the bladder; d = posterior chamber of the free portion of the bladder; e = pneumatic duct connecting the air-bladder with oesophagus; g = gut.

has reverted again to a ground habit of life in comparatively swift currents. Its long, narrow and thick-walled posterior portion shows that the bladder is losing its utility as a hydrostatic organ. In this connection reference may be made to the modification of the swim-

bladder in species of the genus *Garra*[4] in which the torrential species possess a similar type of posterior chamber. This process of retrogression is much more pronounced in *N. hsutschouensis* (Text-figure 1E).

The type of bladder found in *N. papillo-labiatus* (Text-figure 1C), *N. strauchii* (Hora 1930, Text-figure 7) and *N. acuticephalus* (Hora 1930, Text-figure 9) is remarkable in so far as the free bladder is situated very far back in the abdominal cavity and is connected with the bilobed anterior portion and the oesophagus by means of a long tube. In the case of *N. acuticephalus* I surmised that the position of the bladder was probably due to its burrow-

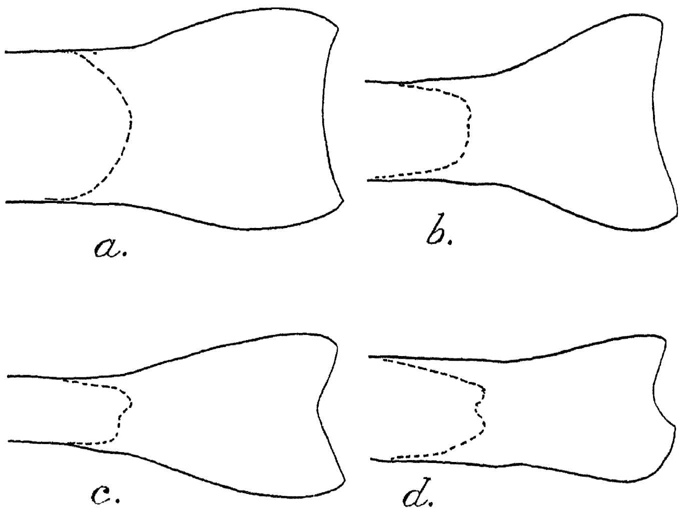


FIGURE 2. Form of caudal fin in the torrential species of *Nemachilus* from Western Tibet. *a*: *Nemachilus gracilis* Day ×2; *b*: *Nemachilus stoliczkae* (Steind.). ×2½; *c*: *Nemachilus tenuicauda* (Steind.). ×3½; *d*: *Nemachilus microps* (Steind.). × 2½.

ing habits. This hypothesis receives support from the fact that in *Pseudapocryptes lanceolatus*, an eel-like burrowing Gobioid fish, the bladder has shifted backwards to the anal region, though in the young stages, when the fish leads a pelagic life, the bladder occupies almost the whole of the abdominal cavity.[5]

In air-breathing fishes of the families *Anabantidae* and *Aphicephalidae*, the air-bladder extends into the caudal region as far as the base of the caudal fin. The utility of this remarkable modification has been explained by me in another place (Hora, *Cur. Sci.* III, pp. 336-338, 1935). It seems probable, however, that the backward position of the bladder in *N. papillo-labiatus*, *N. strauchii* and *N. acuticephalus* enables them to lie horizontally at the bottom and obviates any tendency of the anterior part to rise. This is merely a tentative suggestion as no observations have yet been made on the mode of life of these fishes.

[4] Hora, *Rec. Ind. Mus.* XXII, p. 646 (1921).
[5] Hora, *Current Science* III, p. 336 (1935).

From the above it is clear that the form and structure of the air-bladder is liable to considerable variation and that the modifications noted above are definitely correlated with the diverse types of habitats. In view of these considerations, and also on account of the fact that all possible gradations exist between different types of bladders, I am of the opinion that the character of the air-bladder should not be used for splitting up species into genera. All the same, it is a good index of the type of habitat of a particular species.

Caudal Fin: It is well known that in most of the hill-stream fishes the lower lobe of the caudal fin is distinctly longer and better developed than the upper. A powerful stroke from

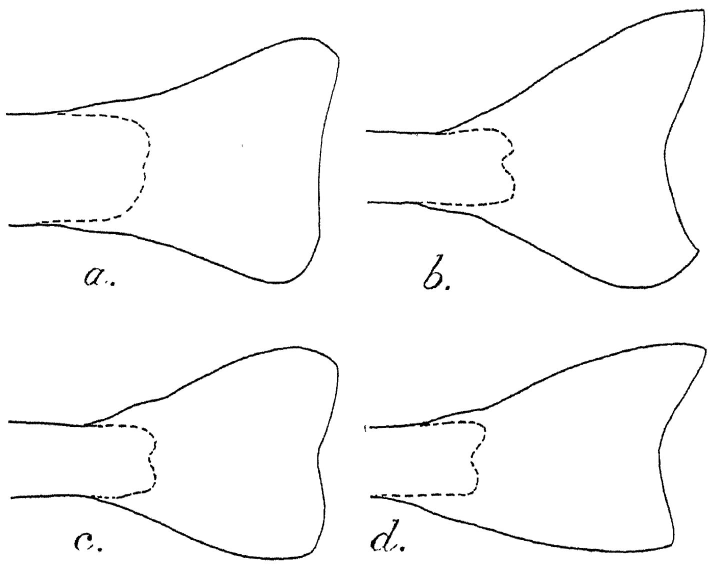


FIGURE 3. Form of caudal fin in the lake inhabiting species of *Nemachilus* from Western Tibet. *a*: *Nemachilus vittatus* (Heckel). ×3; *b*: **Nemachilus panguri**, sp. nov. ×3; *c*: **Nemachilus hutchinsoni**, sp. nov. ×; *d*: **Nemachilus deTerrai**, sp. nov. ×3.

such a fin would not only result in the forward movement of the fish but the differential displacement of water by the two lobes would tend to rotate the anterior end of the fish upwards. This is probably advantageous in the case of torrential fishes when darting from rock to rock in shallow rapid-running waters. By the operation of this device the fish actually moves with its head pointing towards the surface and thus obviates encountering any obstructions in its path. In the torrential species of *Nemachilus* (Text-figure 2), the caudal lobes are either equal or the lower is slightly longer than the upper. But in the case of the free-swimming "lake" species (Text-figure 3), the upper lobe is longer and better developed than the lower. This modification no doubt enables these buoyant fishes to go to the bottom more easily and to keep the head-end directed towards the bottom. The difference in the form of the caudal fin is so marked in the species of the two habitats that it is usually easy to separate, with its help, the specimens with a free air-bladder in the abdominal cavity.

Attention may be directed to the modifications of the air-bladder and the structure of the caudal fin in the species of *Nemachilus* obtained by the Netherland Karakorum Expedi-

tion.[6] The four torrential species, *N. stoliczkae*, *N. gracilis*, *N. tenuicauda* and *N. microps*, with greatly reduced bladder and with the lower lobe of the caudal fin better developed than the upper, were found either in small, rapidly flowing streams or in springs and pools to which they resort for breeding purposes. In the specimens of *N. ladacensis* from Alinazar-Kurghan, the bladder is like that of *N. papillo-labiatus* (Text-figure 1C) and it is likely that the fish leads a bottom life in still or slowly flowing waters. The two lobes of its caudal fin are almost symmetrical, suggesting that the fish does not perform any regular vertical movements.

The three species collected from the plains of Turkestan near Yarkand were obtained from marshes, lakes or canals and, in consequence, the bladder is considerably modified. The structure of the bladder of *N. yarkandensis* is referred to above (p. 300); and that of *Nemachilus* sp. prox. *tarimensis* is similar. The bladder of *Nemachilus* sp. from Rabat Utsang is like that of *N. papillo-labiatus*. It is thus seen that all the three species of *Nemachilus* from Turkestan are adapted to live at the bottom in the marshy areas and do not swim about much. In *N. yarkandensis* and *N. tarimensis* the upper lobe of the caudal fin is longer as is the case in *N. vittatus* (*vide supra*, p. 300), while that of *Nemachilus* sp. is almost symmetrical. It is thus seen that the study of the material obtained by the Netherland Karakorum Expedition supports the hypotheses advanced regarding the ecology and bionomics of the species collected by the Yale North India Expedition.

GEOGRAPHICAL DISTRIBUTION AND ORIGIN OF THE FISH FAUNA

I[7] have often remarked that the fish fauna of the high altitudes of Central Asia is derived from the fauna of the low-lying lands of the neighbouring countries, and this hypothesis is supported by the geographical distribution of the species and the modifications undergone by the air-bladder of the forms living in stationary waters at great heights. Almost all the species of *Nemachilus* found along the slopes of the Himalaya are characterised by the great reduction of their air-bladder, but when they enter lakes, etc., a functional bladder is developed once again. The three new species of the Panggong complex are no doubt descendants of forms once living in torrential streams. When acknowledging the preliminary determinations of the fish collected by the Expedition Mr. Hutchinson made the following observations regarding the distribution of the new species:

> "As you will see from the map, one species (**N. hutchinsoni**) which now seems to occur in small ponds and the very small lake Tsar Tso occupies a region formerly filled by the great freshwater lake which represented Panggong in the late glacial and which extended far to the west. The species from Man (**N. deTerrai**) occurred only in a small lagoon, cut off from the edge of the lake. I saw one specimen actually in the lake, almost certainly of this species, and think that it may have been washed out from the lagoon during a rather heavy storm the night before. . . . . . It is quite clear that all fish are extremely rare in lake Panggong itself at the present time. This is due no doubt partly to its high salt content and still more to its complete lack of higher vegetation which is abundant in the

[6] Hora & Mukerji, Visser's *Karakorum* I, pp. 426-445 (1935).

[7] Hora, *Rec. Ind. Mus.* XXIV, p. 58 (1922); *Phil. Trans. Roy. Soc. London* (B) CCXVIII, p. 268 (1930); *Rec. Ind. Mus.* XXXVI, p. 281 (1934).

lagoons. No doubt the latter are far richer in food stuffs than the lake itself. In the case of the third species (**N. panguri**), from Tso Nyak and Pangur Tso, there is no doubt that the species actually lives at present in the lakes which are fairly rich in vegetation, though it also enters the streams running into them. To my mind there can be no doubt that all three species developed in the late glacial lake but only the third one has remained common in lacustrine environments, the others hanging on as best they can chiefly in small pools in the basin."

It is clear from the above that at the present time the Panggong Lake acts as an effective barrier for the distribution of various species. Further it seems probable that this habitudinal segregation may have induced the development of different species. It is likely that in the late glacial lake there was only one species derived from a torrential stock and that when the environments became restricted, it developed along different lines in different localities and resulted in the production of several new species.[8] This supposition supports the hypothesis of Regan[9] "that as a rule the first step in the origin of a new species is the formation of a community with a new and restricted environment, or with new habits; in other words, that some form of isolation, either localization or habitudinal segregation, is the condition of the development of a new species."

From the modifications of the bladder described above, it does not follow that the lake species cannot enter into brooks or *vice versa.* All species of *Nemachilus* are flattened and adapted for clinging to foreign objects and if ponds, pools and lakes are in communication with brooks it is possible that the species of one habitat may enter the habitat of the other set of species. For instance, it often happens that torrential forms enter springs and pools for breeding purposes. The occurrence of a species (*N. panguri*) in both types of habitats, therefore, does not in any way help to fix its evolutionary status.

N. vittatus seems to have developed in the Kashmir lakes and is endemic in them. *Nemachilus stoliczkae, N. microps, N. tenuicauda* and *N. gracilis* are widely distributed species. The first three are, however, restricted to the high altitudes, whereas *N. gracilis* is found as far down in the Indus as Attock.[10] Almost all the species were obtained by the Netherland Karakorum Expedition not only from the Nubra Valley but also from the Karakash river, which now drains into the Tarim river system. Mukerji and I referred to this discontinuous distribution of the species, but the difficulty has now disappeared for "On the basis of his geomorphological studies, Dr. de Terra has reconstructed the Tertiary drainage pattern of the western part of the Tibetan plateau. A number of rivers ran from west to east, one of them occupying the present valley of the Upper Indus."[11] The close similarity between the torrential fish fauna of the Karakash river and of western Tibet suggests, at any rate, a common drainage for the waters of these two areas at no great distant date and lends great support to the hypothesis advanced by de Terra. Reference may also be made to the occurrence of *N. ladacensis* in Ladakh and the Karakash Valley, but it has to be remembered that only a few specimens of this species are known so far, and, in consequence, its specific limits have not yet been precisely defined.

[8] Dr. A. W. C. T. Herre had a similar problem in the evolution of the seventeen species of fishes of Lake Lanao in the Philippines (*Amer. Nat.* XLVII, pp. 154-162, 1933).

[9] Regan, *Nature,* CXIII, p. 569 (1924).

[10] Hora, *Rec. Ind. Mus.* XXXV, p. 189 (1933).

[11] Hutchinson, *Nature,* CXXXIV, p. 87 (1934).

SYSTEMATIC ACCOUNT

Nemachilus stoliczkae (Steindachner)

1866. *Cobitis stoliczkae*, Steindachner, *Verh. Zool.-bot. Ges. Wien*, p. 793, pl. xiv, fig. 2.
1868. *Nemachilus stoliczkae*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 360.
1876. *Nemacheilus stoliczkae*, Day (in part), *Proc. Zool. Soc. London*, p. 795.
1878. *Nemacheilus stoliczkae*, Day (in part), *Sci. Res. 2nd Yarkand Miss. Ichthyol.*, p. 14, pl. v, fig. 2.
1878. *Nemacheilus stoliczkae*, Day (in part), *Fish. India*, p. 620, pl. clv, fig. 10.
1889. *Nemachilus stoliczkae*, Day (in part), *Faun. Brit. Ind. Fish. I*, p. 235, fig. 84.
1922. *Nemachilus stoliczkae*, Hora, *Rec. Ind. Mus.* XXIV, p. 78.
1935. *Nemachilus stoliczkae*, Hora & Mukerji, Visser's *Karakorum* I, p. 429, pl. iv, fig. 4.

The species was originally described from 12 specimens obtained from Tsho Mararai (Tso Moriri), a lake in the Rupshu Province of Western Tibet at an altitude of 15,500 ft. Day[12] assigned a very wide range of distribution to this species and recorded it from Leh, Snima, Lukong, Chagra, Yarkand, Sarikol and Aktash. Since then it has been reported from widely different places in Central Asia and several varieties of it have been described by Russian ichthyologists[13] from Eastern Turkestan (Tarim River System) and Turkestan (Oxus River System). In 1922, it was pointed out by me that of the large number of specimens referred to *N. stoliczkae* by Day and now preserved in the collection of the Indian Museum, only those that came from Rupshu, Lukong and Chagra could be definitely assigned to this species. A specimen from "Kashmir" was also referred to *N. stoliczkae*, but there seems to have been some mistake about the locality of this example, as the species appears to be restricted to high altitudes. Mukerji and I have recorded this species from Leh, Panamik, Nungstet, Suget-Karaul and Alenazar-Kurghan after studying the material obtained by the Netherland Karakorum Expedition. The first three localities are on the headwaters of the Indus, while the last two are in the Karakash Valley whence the waters flow into the Tarim River. All these places are situated at fairly high altitudes.

The Yale North India Expedition made collections in Western Tibet and obtained specimens from several places to the north-east of the type-locality. Though originally described from a lake,[14] it appears to be a torrential form as it is devoid of a functional air-bladder. It seems likely that the species enters lakes for breeding purposes. Several young specimens were obtained by the Expedition from Yaye Tso; while fully grown specimens were obtained from several streams.

In view of the great confusion that prevails regarding this species, I take this opportunity to give a detailed description with figures from freshly preserved material.

D.3/8; A.3/5; P.13; V.8; C.19

Nemachilus stoliczkae is a long and slender species in which the head and the anterior part of the body are depressed; while the tail region is compressed and whip-like. The

[12] Day, *Proc. Zool. Soc. London*, p. 595 (1876); *Sci. Res. 2nd Yarkand Mission, Ichthyol.*, p. 14, pl. v, fig. 2 (1878).

[13] Herzenstein, *Wiss. Res. Przewalski Central As. Reis. Zool.* III (2), p. 14 (1888); Berg, *Poiss des Eaux Douces de L'U. R. S. S.*, pt. ii, p. 559 (1933).

[14] Mr. Hutchinson informs me that he used a trawl on very favourable ground at the north end (estuary of Peldo-le stream) of Tso Moriri, and found no fish. He is of opinion that the types of *N. stoliczkae* must have come from a stream flowing into the lake. (This is stated to be the case in the original description. G. E. H.)

dorsal profile is gently, but slightly, arched and the ventral profile is straight and horizontal throughout. The head is long and narrow and broadly pointed; its length is contained from 5.6-5.9 times in the total length and from 4.2-4.8 times in the length without the caudal. The head is relatively longer in the female specimens. The greatest width of the head is contained from 1.4-1.6 times and its height at occiput from 1.7-2.1 times in its length. The eye is almost in the middle of the head in female specimens, while in the males the snout is sometimes considerably longer than the postorbital part of the head. The diameter of the eye is contained from 5.2-6.5 times in the length of the head, from 2.3-3.2 times in the length of the snout and from 1.3-1.6 times in the interorbital width. The supraorbital margin of the eye projects slightly beyond the profile and the eyes are not visible from the ventral surface. The mouth is on the ventral surface considerably behind the tip of the snout; it is lunate and horizontal. The lips are thick, continuous and greatly papillated or striated. The posterior lip is reflected backwards so that a portion of the jaw is left bare. The post-labial groove is interrupted in the middle by a slight ridge. The posterior jaw has a sharp, evenly rounded edge. The form of the lips is a very characteristic feature of the species. The barbels are short and stumpy; they are as long as or slightly longer than the diameter of the eye.

The greatest height of the body is above the pectoral fins; the depth of the body is contained from 8.2-10.4 times in the total length and from 6.8-8.6 times in the length without the caudal. The body is scaleless. The lateral line is complete; anteriorly it is continued over the head and divides into two branches behind the eyes. The caudal peduncle is long and narrow; its least height is contained from 3.1-3.6 times in its length.

The dorsal fin is inserted somewhat in advance of the ventral and its commencement is distinctly nearer to the base of caudal than to the tip of snout. The longest ray of the dorsal is considerably higher than the depth of the body below it; its anterior margin is rounded near the tip and the free border is concave. The paired fins are broad, rounded and horizontally placed. The pectoral is somewhat shorter than the head and extends almost half the way to the ventral. The ventral fin extends beyond the anal opening and in some cases almost reaches the anal fin. The anal fin is separated from the caudal by a distance equal to its own length. The caudal fin is almost as long as or slightly longer than the head in males, while in the females it is shorter than the head; its length is contained from 5-5.8 times in the total length. It is slightly emarginate and has two rounded lobes; the lower lobe is better developed and longer than the upper.

Nemachilus stoliczkae exhibits sexual dimorphism. The secondary sexual characters of the male are well developed and of the type described by me[15] for *N. tibetanus*. In the males the head is relatively shorter and the snout is longer than the postorbital part of the head.

In spirit specimens, the general colour is dark above and on the sides and much lighter below. The head and body are mottled with numerous black spots, and in some specimens short, saddle-shaped, black bands are distinguishable along the dorsal surface, especially in the tail region. The dorsal and the caudal fins are spotted. The anteriormost ray of the dorsal fin is provided with a series of conspicuous spots. The dorsal surface of the outer rays of the paired fins is sometimes spotted.

In young specimens, the whole of the body is grayish in colour, though somewhat

[15] Hora, *Rec. Ind. Mus.* XXIV, p. 81 (1922).

lighter on the ventral surface. There is a series of spots along the lateral line and also along the dorsal surface. The fins are without any colour markings.

Distribution. Reference has been made above to the general distribution of the species. Its precise range is, however, difficult to assign till the limits of the forms referred to *N. stoliczkae* from all over Central Asia are properly elucidated. The Yale North India Expedition obtained specimens from the following localities in June-August, 1932:

Between Tangtse and Mugleb, *ca* 13,700 ft. (L 37). 1 specimen (♂).
Migpal-kongma, *ca* 16,082 ft. (L 64). 5 specimens (♂).
Between Chume-sang and Nyagtsu, *ca* 15,500 ft. (L 65). 4 specimens (3 ♀ + 1 ♂).
Nyagtsu, *ca* 15,324 ft. (L 65). 1 specimen (♂).
Tso-skam, *ca* 15,800 ft. (L 77b). 1 specimen (♀).
Yaye Tso, *ca* 15,373 ft. (L 78). 18 specimens (young).

Remarks. *Nemachilus stoliczkae* can be readily distinguished by the following combination of characters:

(i) The ventrals extend considerably beyond the anal opening.

(ii) The commencement of the dorsal is nearer to the base of the caudal than to the tip of the snout.

(iii) The least height of the caudal peduncle is about 3-4 times in its length.

(iv) The lips are papillated and continuous; the posterior lip is broad and reflected backwards.

Bionomics. From its general build, position and form of the paired fins and the structure of the lips and jaws, *N. stoliczkae* appears to be a torrential species. The absence of a functional swim-bladder indicates that it is a stream form and lives at the bottom. An examination of the stomach contents has shown that it feeds on insect larvae and algal growths that encrust rocks and stones. Caddis-worms, dipterous larvae, eggs (probably of Trichoptera) and slimy matter have been found in the stomachs of specimens dissected from different localities. The length of the alimentary canal is slightly greater than the length of the fish. Some of the specimens opened have been found to harbour worms.

Measurements in millimetres

	♂	♂	♂	♀	♀	♀
Total length including caudal	121.0	106.0	100.0	102.5	96.9	84.5
Length of caudal	21.2	18.8	17.0	18.0	16.2	14.8
Length of head	21.0	18.0	17.8	18.5	19.0	16.4
Width of head	15.0	11.5	11.3	12.5	12.1	9.3
Height of head	11.8	9.2	9.8	10.4	9.0	7.8
Depth of body	14.0	10.3	10.7	9.8	10.2	10.2
Length of snout	10.0	8.8	7.8	7.6	8.2	7.0
Diameter of eye	4.0	2.9	2.8	3.0	3.0	2.8
Interorbital width	5.5	4.0	4.0	3.9	5.0	3.6
Length of caudal peduncle	23.6	20.0	20.0	21.0	20.0	18.0
Least height of caudal peduncle	7.0	6.4	5.5	6.2	5.8	5.0
Longest ray of dorsal	18.0	15.1	14.0	15.0	14.8	11.0
Longest ray of anal	15.5	13.6	12.0	14.0	14.0	10.5
Length of pectoral	18.5	16.0	14.5	15.8	15.0	12.0
Length of ventral	15.6	14.5	13.0	12.5	13.0	11.0
	L 66	L 64			L 65	

Nemachilus gracilis Day

1876. *Nemacheilus gracilis*, Day, *Proc. Zool. Soc. London*, p. 798.
1878. *Nemacheilus gracilis*, Day, *Sci. Res. 2nd Yarkand Miss. Ichthyology*, p. 16, pl. iv, fig. 5.
1878. *Nemacheilus gracilis*, Day, *Fish. India*, p. 621.
1889. *Nemachilus gracilis*, Day, *Faun. Brit. Ind. Fish.* I, p. 257.
1898. *Nemachilus stoliczkae*, Alcock (*nec* Steindachner), *Rep. Nat. Hist. Pamir Bound. Comm.*, p. 38.
1922. *Nemachilus gracilis*, Hora, *Rec. Ind. Mus.* XXIV, p. 74.
1933. *Nemachilus gracilis*, Hora, *Rec. Ind. Mus.* XXXV, p. 189.
1935. *Nemachilus gracilis*, Hora & Mukerji, in Visser's *Karakorum*, I, p. 430, pl. iv, fig. 2.

Nemachilus gracilis appears to be one of the commonest loach of the Indus River and its range extends from very high altitudes to as low down as Attock in the North-Western Frontier Province. Few specimens of the species were also obtained by the Netherland Karakorum Expedition from the Karakash Valley. In the collection of the Yale North India Expedition, *N. gracilis* is represented from the following localities. The specimens were collected during May to July, 1932.

Stream 1 mile of Dras, *ca* 10,100 ft. (K 76). 6 specimens (young).
Dras, *ca* 10,144 ft. (K 77). 22 specimens (9 ♂ — 13 ♀).
Spring below Kargil, *ca* 8,790 ft. (K 81). 1 specimen (♂).
Above Leh, *ca* 15,000 ft. (L 25). 3 specimens (young).
Between Tangtse and Mugleh, *ca* 13,700 ft. (L 37). 1 specimen (♂).
Kyam rivulet, *ca* 15,500 ft. (L 59). 1 specimen (young).
Kyam, a pool below camp, *ca* 15,500 ft. (L 60). 1 specimen (♂).
Yalapuk, *ca* 13,521 ft. (L 79). 2 specimens (young).
Sta-rtsak-puk Tso, *ca* 14,889 ft. 4 specimens (young).

The above distribution shows that the species frequents pools in the course of streams, springs and lakes for breeding purposes as young specimens were collected from such localities. It is essentially a torrential species of wide range.

N. gracilis is readily distinguished by the fact that, as a rule, the ventrals do not extend as far as the anal opening, the eye is almost in the middle of the head and the ventrals commence in advance of the dorsal. The structure of the lower lip is also characteristic of the species.

The air-bladder is of the usual reduced type, consisting of two lateral chambers enclosed in bone. The alimentary canal is simple and not much convoluted; its length is about three-fifths of the total length of the fish. The food consists of insect larvae, mostly free-living Diptera and Trichoptera, and of the slime encrusting rocks and stones in rapid current. The small, fan-shaped, horizontal paired fins, reduced air-bladder and its food strongly suggest that the fish lives in very fast currents. Young specimens were collected from underneath stones in a rivulet.

In the mature females, the ovaries occupy almost the whole of the abdominal cavity and even the alimentary canal is flattened out. The eggs are of a fairly large size (diameter about 1.25 mm.).

Nemachilus microps (Steindachner)

1866. *Cobitis microps*, Steindachner, *Verh. Zool.-bot. Ges. Wien*, XVI, p. 794, pl. xii, fig. 3.
1868. *Nemachilus microps*, Günther, *Vat. Fish. Brit. Mus.* VII, p. 357.
1878. *Nemachilus microps*, Day, *Sci. Res. 2nd Yarkand Miss.*, *Ichthyology*, p. 17.
1922. *Nemachilus microps*, Hora, *Rec. Ind. Mus.* XXIV, p. 80.
1935. *Nemachilus microps*, Hora & Mukerji, in Visser's *Karakorum*, I, p. 430, pl. iv, fig. 3.

I refer to *Nemachilus microps* 4 specimens, from 30 to 86 mm. in total length, collected by the Yale North India Expedition on the 27th of August 1932 from underneath large stones in the bed of a stream flowing into the west end of the Tso-Moriri lake about 14,853 feet above sea level. The two larger specimens are females with fully developed ovaries. The eggs are minute and the ovaries do not extend forwards beyond the middle of the abdominal cavity. The air-bladder is reduced and enclosed in bony capsules, as is characteristic of the stream-dwelling forms. The alimentary canal is about as long as the length of the fish and the stomach contents show that the fish feeds on white, slimy stuff that is found encrusting rocks and stones.

In my key to the species of *Nemachilus* from Central Asia in the collection of the Indian Museum (1922, p. 73) *N. microps* was separated from the ♀ of *N. yasinensis* by the relative lengths of the anal fin and of the caudal peduncle. In the specimens now before me the portion of the caudal peduncle is much less than the length of the anal fin, but in all other respects they agree with the other specimens in the Indian Museum collection. In *N. yasinensis* the caudal peduncle is low, while in the four specimens from Western Tibet it is two-fifths as high as long. In the earlier specimens, the caudal peduncle is one-third as high as long. These differences do not seem to me sufficient to justify the erection of a new species in such a variable genus. For future reference, however, I give below measurements of two mature female specimens.

The species was originally described from 10 specimens, 4 from Leh and 6 from "Phirse-Bach in einer Hohe von circa 16000 Fuss bei Manechan in Rupshu (Juli 1865)." The specimens in the collection of the Yale North India Expedition were also collected in the Rupshu Province, Western Tibet.

Measurements in millimetres

	♀	♀
Total length including caudal	86.0	86.0
Length of caudal	15.6	15.5
Length of head	15.0	16.0
Width of head	9.5	11.2
Height of head	7.5	7.0
Depth of body	8.8	9.5
Length of snout	5.5	6.2
Diameter of eye	2.8	2.6
Interorbital width	3.8	3.8
Length of caudal peduncle	13.2	12.8
Least height of caudal peduncle	5.3	5.0
Longest ray of dorsal	11.6	12.5
Longest ray of anal	10.5	10.0
Length of pectoral	12.2	12.5
Length of ventral	11.5	11.0

Nemachilus tenuicauda (Steindachner)

1866. *Cobitis tenuicauda*, Steindachner, *Verh. Zool.-bot. Ges. Wien*, XVI, p. 792, pl. xvii, fig. 3.
1868. *Nemachilus tenuicauda*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 357.
1922. *Nemachilus tenuicauda*, Hora, *Rec. Ind. Mus.* XXIV, p. 79.
1935. *Nemachilus tenuicauda*, Hora & Mukerji, in Visser's *Karakorum*, I, p. 430.

There is a single, mature, female specimen of *Nemachilus tenuicauda*, about 62 mm. in total length; it was collected by the Expedition from a pool in a swamp by Sta-rtsak-puk Tso at an altitude of 14,885 feet. It is a small species and was originally collected from a small brook in Western Tibet. It is also known from Leh and the Nubra Valley.

The ovaries occupy only the posterior half of the abdominal cavity. The air-bladder is reduced and enclosed in two bony capsules. The length of the alimentary canal is about seven-tenths of the total length of the fish. The food consists of Dipterous and Trichopterous larvae and of insect eggs. The long and narrow caudal peduncle indicates that the species lives in turbulent waters.[16]

Nemachilus vittatus (Heckel)

1838. *Cobitis vittata*, Heckel, *Fische Kaschm.*, p. 80, pl. xii, figs. 3 and 4.
1844. *Cobitis vittata*, Heckel, in Hugel's *Kashmir* IV, p. 382, fig.
1922. *Nemachilus vittatus*, Hora, *Rec. Ind. Mus.* XXIV, p. 74.
1930. *Nemachilus vittatus*, Hora, *Journ. Bombay Nat. Hist. Soc.* XXXIV, p. 379 (air-bladder structure).

Nemachilus vittatus is represented by 40 specimens in the collection of the Yale North India Expedition; of these 33 are from the Wular Lake and 7 from a small lake at Shadipur. The Wular Lake specimens were dredged at Kiuhnus. Though a lake form, *N. vittatus* appears to be a bottom-living species and, in consequence, is devoid of a free air-bladder in the abdominal cavity. The two lateral chambers are large and lie next to the skin as the bony capsule is incomplete in that region. The alimentary canal is four-fifths of the total length of the fish. The food consists of algae, mud, insect larvae, leeches, etc.

The species exhibits well marked sexual dimorphism and the secondary sexual characters of the males are similar to those of the other species described in this paper. The gonads were ripe towards the end of April when the specimens were collected. The ovaries occupy almost the whole of the abdominal cavity and the eggs are of a relatively large size.

Of the 40 specimens obtained by the Expedition, 24 are females and 16 are males, giving a percentage of 60 females and 40 males. Usually the males predominate in collections as the females are of rather secretive habits, but in this case the dredge used seems to have made a considerable difference in the proportional representation of sexes in the collection.

Nemachilus deTerrai, sp. nov.

D./38; A.2/5; P.10; V.7; C.16

Nemachilus deTerrai is a long and slender species in which the head and the anterior part of the body are slightly depressed, while the posterior part, especially the tail region, is compressed and whip-like. The head is moderately long and broadly pointed; its length

[16] Hora, *Phil. Trans. Roy. Soc. London* (B) CCXVIII, pp. 250-254 (1930).

is contained from 5.7-6.2 times in the total length and from 4.6-5 times in the length without the caudal. The width of the head is contained from 1.4-1.8 times and the height of the head from 1.6-1.8 times in the length of the head. The eye is situated somewhat nearer

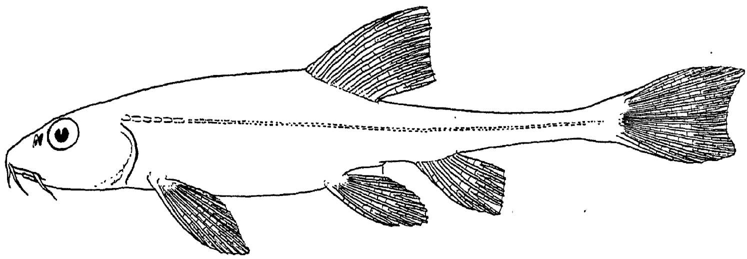


FIGURE 4. Lateral view of a female specimen of **Nemachilus deTerrai**, sp. nov. × 1½.

the tip of the snout than to the opercular margin; its superior border projects slightly beyond the dorsal profile of the head, but it is slightly visible from the ventral surface. The diam-

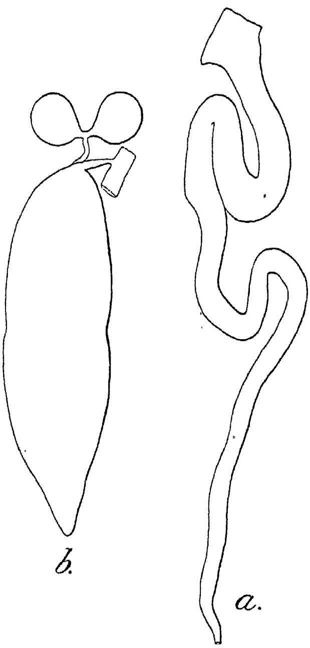


FIGURE 5. Alimentary canal and air-bladder of a male specimen of **Nemachilus deTerrai**, sp. nov. × 2½.
a: alimentary canal; *b*: air-bladder.

eter of the eye is contained from 4-4.7 times in the length of the head, from 1.4-1.8 times in the length of the snout and from 1-1.4 times in the interorbital width. The mouth is lunate and transverse; it is situated on the ventral surface somewhat behind the tip of the snout and is bordered by fleshy lips. The lips are striated; the posterior lip is interrupted in the middle and reflected towards the sides so that a small, triangular portion of the

posterior jaw is left bare. The posterior jaw is sharp and shovel-like and the anterior jaw lies as a hood in front of it. The barbels are thin and long; the inner rostrals are as long as the diameter of the eye while the other two pairs are much longer.

Some of the specimens are heavily parasitised by worms, so that the depth of the body is liable to considerable variation. The depth of the body is contained from 8.5-9.9 times in the total length and from 7-7.6 times in the length without the caudal. Behind the gill-opening and above the base of the pectoral fin, the lateral line is represented by a thin-walled, broad tube beyond which it is faintly marked, though it is continued to the base of the caudal fin. The caudal peduncle is long and narrow; its least height is contained from 4.8-6.4 times in its length. In the male specimens the least height is either equal to or greater than the diameter of the eye while in the females it is considerably less.

The dorsal fin is inserted slightly in advance of the ventrals and its commencement is considerably nearer to the tip of the snout than to the base of the caudal; it is longer than the head; its posterior edge is truncate or slightly crenulate. The paired fins are horizontally placed; the pectoral fin is broad but pointed in the middle; it is somewhat shorter than the head and separated from the ventral by a distance equal to half of its length. The ventrals extend beyond the anal opening and in some cases even beyond the commencement of the anal fin which extends about half the way to the base of the caudal. The caudal fin is longer than the head; its posterior border is concave with the upper rays considerably longer than the lower.

Nemachilus deTerrai exhibits sexual dimorphism. The secondary sexual characters of the male are similar to those described above for *N. stoliczkae*. The difference in the height of caudal peduncle is also well marked in the two sexes.

Air-bladder: The air-bladder is divided into two parts, (i) the anterior part consisting of two round, lateral chambers enclosed in bony capsules and connected by a short, transverse tube, and (ii) a large posterior part lying free in the abdominal cavity and connected with the transverse tube by a short tube. By another short, but broader, tube it is connected with the oesophagus. The posterior part is slightly constricted in the middle so that it consists of two chambers. In a specimen about 110 mm. in total length, the measurements of the bladder are as follows:

Total length of bladder	25.00 mm.
Length of posterior part	20.00 mm.
Width of anterior part	7.50 mm.
Width of posterior part	7.50 mm.
Transverse diameter of each anterior chamber	3.25 mm.
Length of tube between two anterior chambers	1.00 mm.
Length of tube between anterior and posterior parts	1.70 mm.

The above measurements are of the bladder after its removal from the bony capsules.

The bony capsules of the air-bladder lie just beneath the skin and are distinctly visible from the external surface.

In spirit specimens the general colour of the body is pale-olivaceous. There is usually a black, fairly broad streak along the lateral line which is composed of a series of darker blotches. In some the dorsal surface is gray so that there is a lighter stripe between the dorsal band and the lateral line. The dorsal and the caudal fins are provided

with 2 to 4 series of spots and the anterior ray of the dorsal fin is provided with 3 or 4 black spots along the front margin. The dorsal surface of the paired fins and the anal fin are sometimes provided with black patches.

Locality: Nine specimens of **N. deTerrai** were obtained by the Yale North India Expedition from the Man Lagoon on the 4th and 5th of July. It is an isolated lagoon in the drowned valley at an altitude of 14,008 ft.

Remarks: The most distinguishing feature of **N. deTerrai** is the great length of its dorsal fin. The other fins are also elongated. The form of the caudal fin is very characteristic of the species.

Bionomics: From the extensive air-bladder in the abdominal cavity, and from the nature of the fins, it is clear that the fish is adapted to live in stationary waters. The general facies, especially the whip-like caudal peduncle, suggests that the fish is a fast swimmer. For feeding purposes, the fish probably adheres to rocks with the help of the paired fins and scrapes off animal and vegetable matter. In the case of two specimens dissected the stomach was found to be full of a whitish, pulpy material without any sand or small bits of stones. The alimentary canal is not much convoluted; its length is about three-fifths of the total length. It would thus seem to be a flesh-eating species.

Measurements in millimetres

	♂	♂	♂	♀	♀
Total length including caudal	104.0	95.0	95.0	83.0	68.0
Length of caudal	21.0	18.5	19.0	14.8	11.5
Length of head	17.9	16.5	15.2	14.0	12.0
Width of head	11.5	9.2	8.8	9.8	7.0
Height of head	10.9	10.0	9.5	8.2	6.5
Depth of body	12.0	10.5	9.6	12.0[17]	8.0
Length of snout	6.5	6.5	6.5	5.0	4.5
Diameter of eye	4.2	3.5	3.8	3.5	2.8
Interorbital width	5.2	5.0	4.0	3.5	3.2
Length of caudal peduncle	23.0	21.6	20.0	20.5	16.0
Least height of caudal peduncle	4.8	4.3	4.0	3.2	2.5
Longest ray of dorsal	19.8	17.8	17.0	15.0	14.2
Longest ray of anal	15.0	14.0	13.2	12.5	9.0
Length of pectoral	17.2	15.0	15.0	13.2	11.5
Length of ventral	15.5	13.8	14.0	11.5	10.0

Nemachilus hutchinsoni, sp. nov.

D.3/8; A.2/5; P.9; V.7; C.16

In **Nemachilus hutchinsoni** the head and the anterior part of the body are depressed so that the ventral surface is somewhat flattened. In the tail region the body is compressed and whip-like. The head is short, high and broadly pointed; its length is contained from 5.4-5.6 times in the total length and from 4.4-4.6 times in the length without the caudal. The width of the head is contained from 1.4-1.6 times and the height of the head at the occiput 1.6 times in its length. The eyes are situated nearer to the tip of the snout than to the posterior

[17] The abdominal portion is greatly swollen due to heavy parasitisation by worms.

margin of the operculum; they are dorsolateral in position and invisible from the ventral surface. The diameter of the eye is contained from 4.1-4.9 times in the length of the head, from 1.5-1.7 times in the length of the snout and from 1-1.5 times in the interorbital width. The mouth is lunate and transverse; it is on the ventral surface not very far behind the tip of the snout and is bordered by fleshy lips which are continuous at the angles of the mouth. The ventral lip is divided in the middle almost imperceptibly. The lips are folded, fimbriated and covered with minute papillae. The lower jaw is sharp and horizontal, while the upper jaw is vertical and lies in front of the lower. The barbels are thin and long; the inner rostrals are almost as long as the diameter of the eye, while the other two pairs are much longer.

The only mature female specimen is heavily parasitised and, in consequence, the depth of its body is relatively greater. In the male specimens the depth of the body is contained from 7.7-8 times in the total length and from 6.2-6.6 times in the length without the caudal. The lateral line is well developed above the base of the pectoral fin beyond which it is incon-

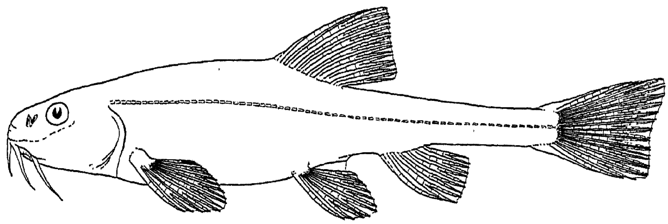


FIGURE 6. Lateral view of a female specimen of **Nemachilus hutchinsoni,** sp. nov. Nat. size.

spicuous. The caudal peduncle is long but fleshy; its least height is contained from 4.4-5.1 times in its length. The least height is either greater than or equal to the diameter of the eye; in the female specimen the least height is considerably greater than the diameter of the eye.

The dorsal fin is inserted in advance of the ventrals and its commencement is considerably nearer to the tip of the snout than to the base of the caudal fin; it is somewhat longer than the head but this character is more marked in the female specimen. The posterior margin of the fin is almost truncate. The paired fins are horizontally placed and are broadly pointed in the middle. The pectoral is shorter than the head and is separated from the ventral by a considerable distance. The ventral extends beyond the anal opening and almost reaches the anal fin which extends half way to the base of the caudal fin. The caudal fin is somewhat longer than the head; it is slightly emarginate with the two lobes broadly rounded. The upper lobe is better developed and longer than the lower.

Nemachilus hutchinsoni exhibits sexual dimorphism and the secondary sexual characters of the male are similar to those of the other species discussed here. The mature male and female specimens are from two different localities so one cannot be certain that they belong to the same species. A male specimen has been selected as the type of the species. Attention may be directed to the fact that in the female specimen the caudal peduncle is relatively deeper and the dorsal fin longer than is the case in the males.

Air-bladder. The air-bladder is of the usual Diplophysid type. The anterior part is dumbbell-shaped and is enclosed in two bony capsules while the posterior part, which is deeply

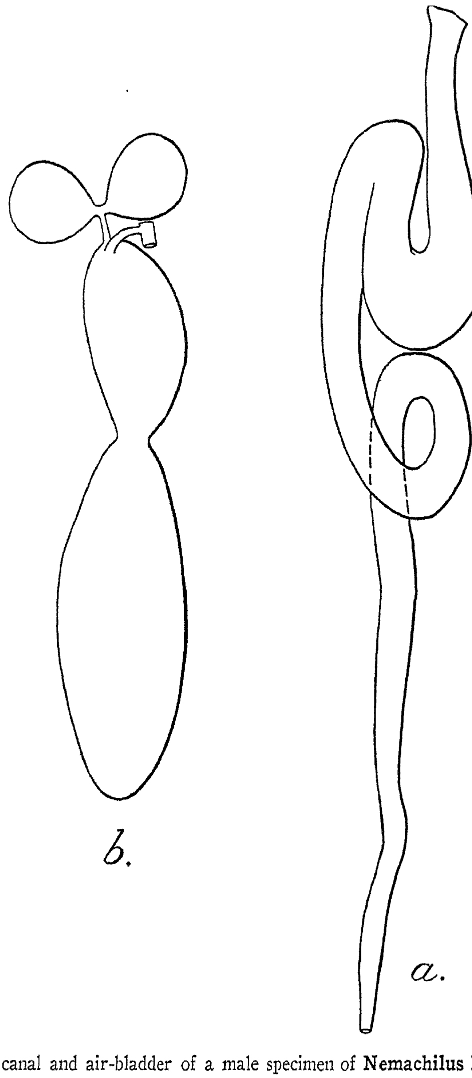


FIGURE 7. Alimentary canal and air-bladder of a male specimen of **Nemachilus hutchinsoni,** sp. nov. × 4.
a: alimentary canal; *b*: air-bladder.

constricted to form two chambers, lies free in the abdominal cavity. The two anterior chambers are connected by a short tube and the anterior and posterior parts of the bladder are connected by a short tube. In a male specimen about 90 mm. in total length the measurements of the bladder are as follows:

Total length of bladder	21.60 mm.
Length of posterior part	18.40 mm.
Width of anterior part	7.00 mm.
Width of posterior part	4.80 mm.
Transverse diameter of each anterior chamber	3.20 mm.
Length of tube between two anterior chambers	0.66 mm.
Length of tube between two parts of bladder	0.90 mm.

The above measurements are of the bladder after its removal from the bony capsules.

The bony capsules are incomplete in the part where they touch the skin so that their position can be readily made out from the external surface.

In spirit specimens the general colour of the body is pale-olivaceous. A series of fairly broad blotches is present along the lateral line and in some specimens they unite to form a longitudinal band. Along the dorsal surface, especially in the tail region, there are a number of saddle-shaped bands. The dorsal surface and the sides are further irrorated with small black dots. The dorsal and the caudal fins are provided with two to three broad bands. The anal and the ventral fins are provided with one or two bands each.

Localities: In all six specimens were collected by the Yale North India Expedition during June 1932 from the following localities:

About 3 miles west of Mugleb, *ca.* 13,525 ft. (L 35). 1 specimen (young).
Pond between Durbuk and Tangtse, *ca.* 13,000 ft. (L 36). 3 specimens (♂).
Tsar Tso, *ca.* 13,950 ft. (L 39). 1 specimen (young).
Pool isolated from the river at Lukung, *ca.* 14,164 ft. (L 40). 1 specimen (♀).

It is seen from the above that the species occurs in pools, and small lakes.

Bionomics: The species is adapted for life in stationary waters of lakes where its well developed air-bladder enables it to swim about freely at different depths. It feeds on insect larvae and pupae that encrust rocks and stones. Its horizontal, paired fins enable it to adhere to rocks and its lower jaw appears to be capable of acting as a shovel for rasping off encrusting organisms. The alimentary canal is a simple tube without many convolutions and its length is about three-fifths of the total length. The eggs are small and the ovaries extend right up to the anterior end of the abdominal cavity.

Measurements in millimetres

	♀	♂	♂	♂
Total length including caudal	110.0	94.0	90.0	89.0
Length of caudal	20.5	18.5	17.0	15.5
Length of head	19.5	17.0	16.5	16.0
Width of head	12.2	11.0	11.0	11.0
Height of head	11.9	10.5	10.5	10.0
Depth of body	17.0	12.2	11.5	11.0
Length of snout	6.9	6.5	6.0	6.0
Diameter of eye	4.0	4.0	3.6	3.6
Interorbital width	5.0	4.2	4.0	5.5
Length of caudal peduncle	22.0	20.5	19.5	18.0
Least height of caudal peduncle	5.0	4.0	4.0	3.6
Longest ray of dorsal	21.5	17.0	16.0	17.5
Longest ray of anal	16.5	12.0	12.5	12.6
Length of pectoral	17.5	15.5	15.0	15.0
Length of ventral	15.5	13.2	13.2	13.5
	L 40		L 36	

Nemachilus panguri, sp. nov.

D.3/8; A.2/5; P.9; V.7; C.16

The build of **Nemachilus panguri** is more or less of the same type as in the two preceding species. The head and the anterior part of the body are somewhat depressed while the tail region is slightly compressed and whip-like. The head is moderately long and broadly pointed anteriorly; its length is contained from 5-5.6 times in the total length and from 4-4.6 times in the length of the caudal. The width of the head is contained from 1.78-1.95 times and the height of the head from 1.73-1.76 times in its length. The position of the eye in the length of the head is variable; the upper margin of the orbit is slightly raised above the dorsal profile of the head and the eyes are not visible from the ventral surface. The diameter of the eye is contained from 4-5 times in the length of the head, from 1.5-2 times in the length of the snout and from 1-1.1 times in the interorbital width. The mouth is small, lunate, transverse and horizontal; it is situated on the ventral surface slightly

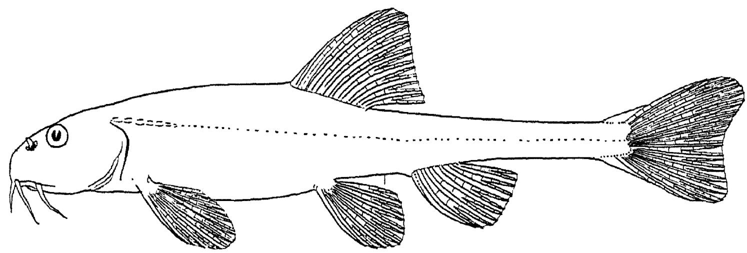


FIGURE 8. Lateral view of a female specimen of **Nemachilus panguri**, sp. nov. from Tso Nyak. × 1½.

behind the tip of the snout and is bordered by fleshy and papillated lips. The lower lip is interrupted in the middle. The posterior jaw is sharp, truncate and horizontal. The three pairs of barbels are fairly well developed; the inner rostrals are as long as or slightly longer than the diameter of the eye while the other two pairs are much longer.

The depth of the body is contained from 9-10.5 times in the total length and from 7.3-8.6 times in the length without the caudal. Behind the gill-opening and above the base of the pectoral fin, the lateral line is represented by a thin-walled, broad tube beyond which it is faintly marked to the base of the caudal fin. The caudal peduncle is long and narrow; its least height is contained from 5.3-6.5 times in its length. In both the sexes the least height of the caudal peduncle is usually less than the diameter of the eye, but in some female specimens it is greater than the diameter of the eye.

The dorsal fin is inserted slightly in advance of the ventrals and its commencement is either equidistant between the tip of the snout and the base of the caudal or nearer to the tip of the snout than to the base of the caudal; it is almost as long as the head; its posterior border is slightly arched. The paired fins are broad and horizontal; the pectorals are pointed in the middle, especially in the males. The pectoral fin is considerably shorter than the head and is separated from the ventral by a distance almost equal to half of its length. The ventrals extend beyond the anal opening and reach the base of the anal fin. The anal fin is similar in shape to the dorsal. The caudal fin is almost as long as the head; it is slightly emarginate with the upper lobe considerably longer and better developed than the lower.

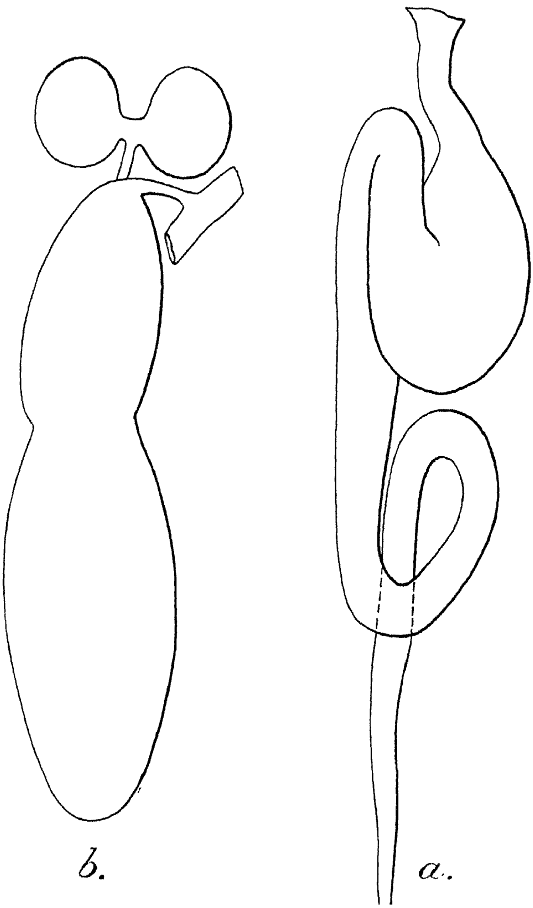


FIGURE 9. Alimentary canal and air-bladder of **Nemachilus panguri,** sp. nov. × 5. *a*: alimentary canal of a male specimen; *b*: air-bladder of a female specimen.

Nemachilus panguri exhibits well-marked sexual dimorphism. The secondary sexual characters of the male are similar to those of other Nemachiloid fishes of Central Asia.

Air-bladder: The air-bladder of **N. panguri** is similar to that of **N. deTerrai.** In a female specimen about 95 mm. in total length, the measurements of its various parts were as follows:

Total length of bladder	26.6 mm.
Length of posterior part	19.0 mm.
Width of anterior part	6.7 mm.
Width of posterior part	5.8 mm.
Transverse diameter of each anterior chamber	3.0 mm.
Length of tube between two anterior chambers	0.9 mm.
Length of tube between anterior and posterior parts of bladder	1.4 mm.

The above measurements are of the bladder after its removal from the bony capsules.

The bony capsules of the air-bladder lie just beneath the skin and are distinctly visible from outside.

The ground color of the spirit specimens is pale-brown, the dorsal surface being somewhat darker than the ventral. There are patches of dark colour along the lateral line and saddle-shaped bands along the dorsal surface. These colour markings are more pronounced in the younger specimens. The head is grayish above and pale-yellow below. The dorsal fin is provided with 4-5 dark bands in the adult while in the smaller individuals there may be only one or two bands. The ventral and the anal fins are also similarly marked. The caudal fin is provided with 3 broad bands, but in young specimens only one broad, prominent band is present in the middle of the fin.

Localities: Several specimens in **N. panguri** were collected by the Yale North India Expedition in August 1932 from the following localities:

Pangur Tso, *ca.* 14,203 ft. (L 74).	Several young, half-grown and adult specimens.
Tso Nyak (L 71a).	Several young, half-grown and adult specimens.

Remarks: **Nemachilus panguri** seems to be a very close ally of **N. deTerrai** from which it differs in proportions, especially of the eye and the dorsal fin. Though the differences do not seem to be markedly specific, it is better to regard the two species as distinct in the present state of our knowledge of the fish fauna of Western Tibet.

Bionomics: Like the two preceding species, **N. panguri** is also adapted to live in stationary waters where it can dart from place to place with the help of the whip-like caudal peduncle or make vertical movements with the help of the large swim-bladder. The stomach contents of a male specimen consisted of Chironomid larvae with their sandy and calcareous cases. The alimentary canal is only slightly convolute; its length being seven-tenths of the total length of the fish.

Measurements in millimetres

	♂	♂	♂	♀
Total length including caudal ..	73.0	84.0	98.0	58.0
Length of caudal	12.6	15.5	18.6	11.0
Length of head	13.0	16.0	19.6	11.[illegible]
Width of head	7.1	8.2	11.0	6.2
Height of head	7.5	9.1	11.5	6.5
Depth of body	7.4	8.0	10.9	5.8
Length of snout	4.8	5.9	8.0	3.8
Diameter of eye	3.2	3.2	4.0	2.5
Interorbital width	3.5	3.5	4.2	2.5
Length of caudal peduncle	15.8	18.0	20.2	13.0
Least height of caudal peduncle	2.5	3.0	3.8	2.0
Longest ray of dorsal	14.0	16.1	19.2	11.0
Longest ray of anal	10.5	12.0	12.5	12.2
Length of pectoral	12.9	14.5	14.5	9.8
Length of ventral	11.2	12.9	14.1	7.8

Botia birdi Chaudhuri

1909. *Botia birdi*, Chaudhuri, *Rec. Ind. Mus.* III, p. 339.
1922. *Botia birdi*, Hora, *Rec. Ind. Mus.* XXIV, p. 319.

The Yale North India Expedition collected a dozen specimens of *Botia birdi* at Srinagar during March 1932. The specimens vary from 86 mm. to 138 mm. in total length. The colour pattern on the body is subject to considerable variation.

In 1922, I assigned Day's *B. geto* to the synonymy of *B. birdi*, but on an examination of the material from the Eastern Himalayas it became clear that Day's form represented a new species,[18] differing from *B. birdi* mainly in the nature and form of its head.

[18] Hora, *Rec. Ind. Mus.* XXXIV, p. 571 (1932).

Explanation of Plate XII.

Nemachilus from Western Tibet

Nemachilus hutchinsoni, sp. nov.

Fig. 1. Lateral view of a male specimen. × 1/2.
Fig. 2. Ventral surface of head and anterior part of body of same. × 1 1/2.

Nemachilus panguri, sp. nov.

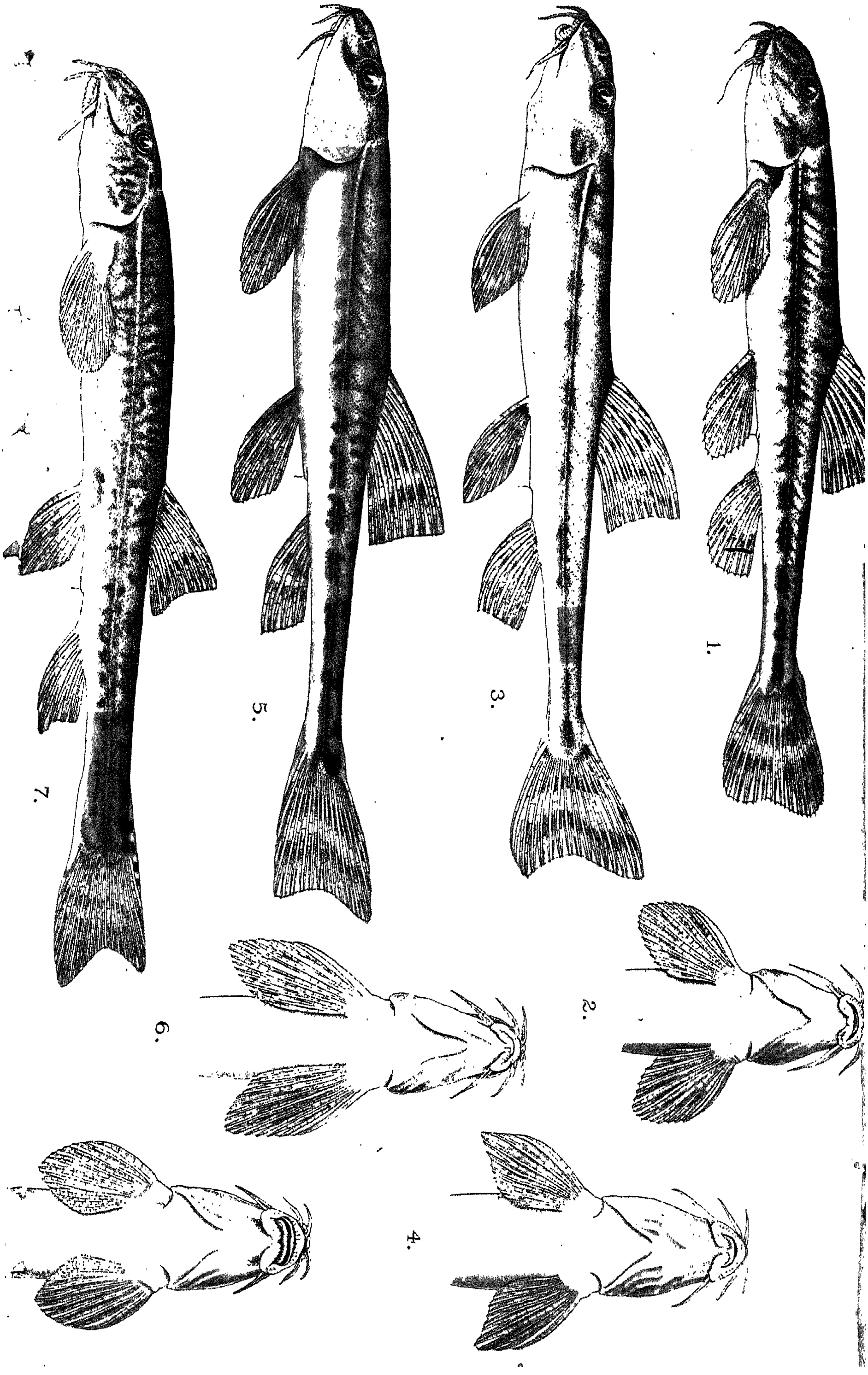
Fig. 3. Lateral view of a male specimen. × 1/2.
Fig. 4. Ventral surface of head and anterior part of body of same. × 1 1/2.

Nemachilus deTerrai, sp. nov.

Fig. 5. Lateral view of a male specimen. × 1/2.
Fig. 6. Ventral surface of head and anterior part of body of same. × 1 1/2.

Nemachilus stoliczkae (Steindachner)

Fig. 7. Lateral view of a male specimen. × 1 1/4.
Fig. 8. Ventral surface of head and anterior part of body of same. × 1 1/4.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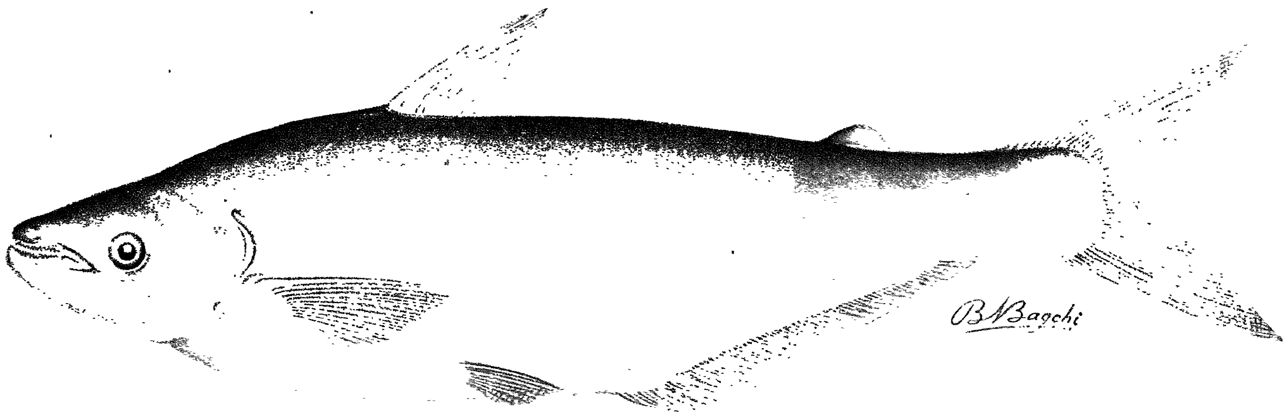
[Reprinted from the *Journal of the Bombay Natural History Society, Vol. XL, No. 2, September* 1938.]

THE GAME FISHES OF INDIA.

By Sunder Lal Hora, d.sc., f.r.s.e., f.z.s. f.r.a.s.b., f.n.i.

(*With one plate and four text-figures*).



The Silond Catfish
Silonia silondia (Hamilton).

[*From the* JOURNAL OF THE BOMBAY NATURAL HIST. SOC., *September* 1938.]

THE GAME FISHES OF INDIA.[1]

BY

SUNDER LAL HORA, D.SC., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I.

Assistant Superintendent, Zoological Survey of India, Calcutta.

(*With one plate and four text-figures*).

Continued from page 678 *of Vol.* xxxix.

IV.—THE SILOND CATFISH.

SILONIA SILONDIA (Hamilton).

CONTENTS.

INTRODUCTION.

Among a great variety of Indian Catfishes, there are four species, *viz.*, *Silonia silondia* (Ham.), *Pangasius pangasius* (Ham.), *Bagarius bagarius* (Ham.) and *Wallagonia attu*[2] (Bloch), which attain a size of about five to seven feet in length, and on account of their voracious habits and powerful build are sometimes called 'Freshwater Sharks'. They cause considerable damage to fisheries

[1] Published with permission of the Director, Zoological Survey of India.

[2] Myers (*Copeia*, p. 98, June 1938) has restricted the use of the generic denomination *Wallago* to *W. dinema* Bleeker and has included the Indian species in his new genus *Wallagonia*.

and are very undesirable in several respects. However, they provide considerable sport to anglers, and are regarded game fishes of no mean value. The present article deals with the *Silond* Catfish, which is perhaps the most powerful of all the four species enumerated above and whose flesh is certainly more prized than that of the others. The following three articles will be devoted to the treatment of the three other so-called freshwater sharks.

NOMENCLATURE AND SYSTEMATIC POSITION.

Hamilton (**3**)[1] who discovered the *Silond* Catfish for science, named it *Pimelodus silondia*, but later workers regarded Hamilton's *Pimelodus* as a generalised, composite genus and split up his group of 33 species into several genera. Swainson (**6**) removed the first two species of Hamilton's *Pimelodus*—*P. silondia* and *P. chandramara*, to a new subgenus *Silonia* of *Ageniosus* (*sic*) which was defined as follows:—

'Body of equal thickness with the head, which is not dilated; eyes very large; cirri two, very minute; adipose dorsal very small, oval; gill-membrane ten-rayed; ventral fin beneath the first dorsal; caudal fin slightly lunate.'

The two species included by Swainson under *Silonia*, *S. lurida* Sw. (=*P. silondia* Ham.) and *S. diaphina* Sw. (=*P. chandramara* Ham.), are quite different from each other, except that both were characterised by Hamilton as possessing only two barbels. *P. silondia* is, however, designated as the type of the species and it is to the fishes of this kind that the generic designation of *Silonia* is now applied.

Probably being unaware of Swainson's classification, Cuvier and Valenciennes (**1**) also proposed a new genus *Silundia* for the same two species of Hamilton's *Pimelodus* and characterised it as follows:—

'Les Silondies sont des siluroïdes, voisines des Bagres, à petite tête lisse, fort semblable à celle des schilbes, à très-petite nageoire dorsale adipeuse, à longue nageoire anale, qui n'ont que deux barbillons maxillaires, et tellement petits, qu'il faut de l'attention pour des découvrir. Leurs rayons branchiostèges sont au nombre de douze. Leurs dents de mâchoires, sur un ou deux rangs seulement, sont plus longues et moins semées que dans les autres siluroïdes. Nous n'en connaissons bien qu'une espèce le *pimelodus silundia* de Buchanan; mais il me paraît que le *pimelodus chandramara* du même auteur s'en rapproche au moins beaucoup.'

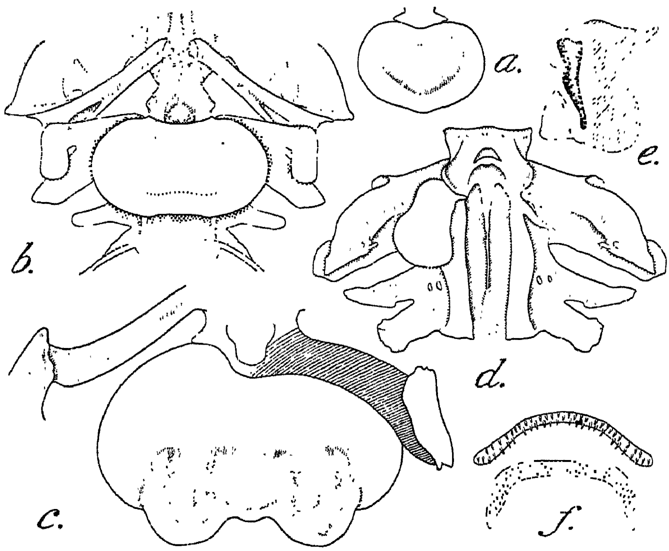
Cuvier and Valenciennes changed the specific name of *Silond* to *Silundia gangetica* and the later workers adopted this name without any reference to Swainson's earlier work. As *Silonia* Swainson has priority over *Silundia* Cuvier and Valenciennes, in accordance with the International Rules of Zoological Nomenclature the species must now be designated as *Silonia silondia* (Hamilton).

As recognised here *Silonia* is a monotypic genus. Some authors have regarded Sykes' (**7**) *Ageneiosus childreni* as a doubtful member of this genus but I (**4**) have placed it in a separate genus *Silonopangasius* Hora. Day (**2**) described a new species of

[1] Numerals in thick type within brackets refer to the serial numbers of the various publications listed in the bibliography at the end of the paper.

Silundia, S. sykesii, from Deccan and was doubtfully of the opinion that it may be synonymous with Sykes' *childreni*. In the collection of the Zoological Survey of India there is a considerable material of the Deccan form. Though both the species possess caniniform teeth which project outside the mouth-opening, *Silonopangasius childreni* has two pairs of barbels while *Silonia silondia* has only one pair. The structure of the air-bladder is also different in the two species. Moreover, the Deccan form rarely exceeds a foot and a half in length.

Taylor, Day, and Bridge and Haddon described the air-bladder of *S. silondia*,[1] but their accounts differ greatly from one another. On dissecting a number of specimens of various sizes it was observed that the form of the air-bladder undergoes considerable



Text-fig. 1.—Air-Bladder, associated skeletal structures, and dentition of *Silonia silondia* (Ham.).

a. Air-bladder of a specimen 53 mm. in length without caudal. ×3; *b.* Air-bladder of a specimen 131 mm. in length without caudal. ×3; *c.* Air-bladder of a specimen 237 mm. in length without caudal. ×2½. The portion shaded by section lines represents a strong fibrous structure by which the bladder is attached to the neighbouring skeletal elements; *d.* Air-bladder of a specimen about 1.070 mm. in length without caudal. ×½. The bladder from the right side is removed to show the nature of the bones to which it is firmly attached; *e.* Longitudinal horizontal section of the air-bladder shown in *d.* ×¾. The portion shaded by section lines represents the solid, fibrous part of the bladder, while its cavity is shaded black with dots; *f.* Upper dentition of a specimen 237 mm. in length without caudal. Nat. size.

changes during growth. I reproduce here (text-fig. 1) four drawings of the air-bladders of specimens 53 mm., 131 mm., 237 mm. and

[1] For references to the accounts of Taylor, Day, and Bridge and Haddon see the synonymy of the species on page 141.

1,070 mm. in length without the caudal, respectively. In both the earlier stages the form corresponds with that described by Bridge and Haddon, while that of the third specimen approaches the type described by Day. Fortunately, Taylor noted that his specimen was about 8 pounds in weight, so he was certainly dealing with a much larger specimen than those examined either by Day or by Bridge and Haddon. Taylor's description more or less corresponds with the form of the bladder of the largest specimen examined by me. Nair (5) has recently given an account of the changes in the internal structure of the air-bladder of *Silonia silondia* during growth.

The genus *Silonia* may now be defined as follows:—

The body is elongated and compressed. The head and body are covered with soft skin. The head is of moderate size and is rounded anteriorly. The median fontanel extends throughout the length of the head. The occipital process is sharply pointed posteriorly and there is a considerable space between it and the basal bone of the dorsal fin. The eyes are situated laterally behind the angle of the mouth and are visible both from above and below; they are provided with circular adipose lids. The mouth is anterior, wide and obliquely directed upwards. The lower jaw is somewhat longer than the upper and broadly pointed in the middle. The teeth in the jaws are large and caniniform; they project outside the mouth-opening. There is a continuous U-shaped band of villiform teeth across the palate. The lips are well developed near the angles of the mouth and are continuous. The post-labial groove is widely interrupted in the middle. The nostrils are situated wide apart and are slit-like; the anterior nostrils are along the front edge of the snout while the posterior ones are placed backwards and inwards. There are only two small maxillary barbels which lie in grooves and are liable to be overlooked. The dorsal fin is situated considerably in advance of the ventrals; it is provided with a moderately developed bony spine which is roughened externally and serrated internally. A small adipose dorsal is present in the last fourth of the body length. The anal fin is very long. The pectoral fin is provided with a strong, bony spine which is roughened externally and serrated internally. The pelvic fins possess 6 rays each. The caudal fin is deeply forked. The gill-openings are wide. The gill-membranes are deeply notched; they are united with each other but are free from the isthmus. There are 11-12 branchiostegal rays. The air-bladder is greatly reduced, thick-walled and uniform in the earlier stages; it has its long axis transversely disposed and lies across the body of the anterior, modified vertebrae. It is not enclosed in bone but is supported laterally by the transverse processes of the fourth vertebrae.

Genotype:—*Silonia lurida* Swainson 1838=*Pimelodus silondia* Hamilton 1822.

Distribution:—Same as of the only species, *vide infra*, p. 143.

Relationships:—*Silonia* belongs to the family Schilbeidae of the order *Siluroidea*. This family is represented by a number of genera both in the Oriental and the Ethiopian Regions. As I (4)

have remarked elsewhere *Silonia* with one pair of barbels is probably a primitive form in the family, though owing to its highly predaceous habits it has developed large caniniform teeth in both the jaws. Its close allies are represented today by forms like *Pangasianodon* Chevy of Siam and Indo-China, and *Silonopangasius* Hora of Southern India. The former, like *Silonia*, grows to a very large size, while the latter rarely exceeds a foot and a half in length.

SYNONYMY AND DESCRIPTION.

Silonia silondia (Hamilton).

1822. *Pimelodus silondia*, Hamilton, *Fish. Ganges*, pp. 160, 375, pl. vii, fig. 50.
1830. *Pimelodus silondia*, Taylor, *Gleanings in Science*, p. 171 (air-bladder).
1838-39. *Silonia lurida*, Swainson, *Nat. Hist. Fish.*, etc., i, p. 345, fig. 85; *ibid.*, ii, p. 305.
1840. *Silundia gangetica*, Cuvier & Valenciennes, *Hist. Nat. Poiss.*, v, p. 49, pl. ccccxxvi.
1853. *Silundia gangetica*, Bleeker, *Verh. Bat. Gen.*, xxv, p. 118.
1858. *Silundia gangetica*, Blyth, *Proc. As. Soc. Bengal*, p. 28.
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1876. *Silundia gangetica*, Day, *Journ. Linn. Soc. London*, xii, p. 570.
1877. *Silundia gangetica*, Day, *Fish. India*, p. 488, pl. cxiv, fig. 3.
1877. *Silondia gangetica*, Beavan, *Freshw. Fish. India*, p. 136.
1889. *Silundia gangetica*, Day, *Faun. Brit. Ind. Fish.*, i, p. 145, fig. 62.
1894. *Silundia gangetica*, Bridge & Haddon, *Phil. Trans. Roy. Soc. London* (B), clxxxiv, pp. 222, 223 (air-bladder).
1937. *Silonia silondia*, Hora, *Curr. Sci.*, v, p. 352 (affinities and distribution).
1938. *Silonia silondia*, Nair, *Rec. Ind. Mus.*, xl, pp. 5-11, 6 figs. (air-bladder).

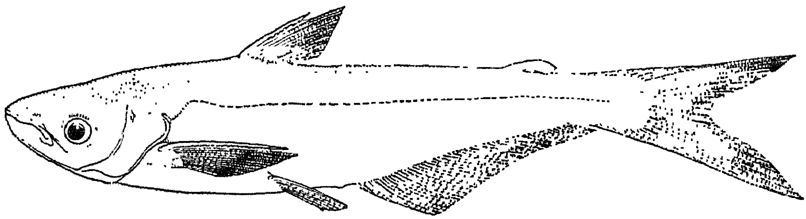
Vernacular Names:—*Silun* (Bengal, for young and half-grown), *Dhāīn* (Bengal, for larger specimens); *Silondia-vacha* (Calcutta); *Silon* (Dinajpore and Rungpur); *Baikar* (Gorakhpur); *Silond* (Punjab); *Ji-lung* and *Silond* (Ooriah and Bengali).

In the higher Bengali dialect this species is known as *Silandha* while its Sanskrit names are *Silendhra* and *Silindha* (*vide* Hamilton's list of Bhagalpur fishes).

B. 11-12; D. 1/7; A. 40-46; P. 11-13; V. 6; C. 17.

Silonia silondia is herring-shaped in its younger stages, but in the adult condition its belly becomes very bulky. The dorsal and ventral profiles are almost equally arched in the young individuals (text-fig. 2 and plate), but in full-grown specimens the ventral profile is greatly arched (text-fig. 3). The length of the head is contained from 5·0 to 5·8 times in the total length and from 4·0 to 4·6 times in the length with the caudal. The head is proportionately shorter in the larger individuals. The width of the head is about two-thirds of its length. The depth of the body undergoes considerable variations with age; it is contained from 4·7 to 7·4 times in the total length and from 4·0 to 6·0 times in the length without the caudal. The eyes are lateral in position and are visible both from above and below; the diameter of the eye is contained from 3·1 to 4·4 times in the length of the head, from

1·2 to 2·0 times in the interorbital width and from 1·0 to 1·5 times in the length of the snout. Proportionately the eyes are much smaller in larger individuals. The eyes are provided with narrow adipose lids. The head is provided with a median fontanel along its entire length which is shallow in front and somewhat



Text-fig. 2.—Lateral view of a young specimen of *Silonia silondia* (Ham.) 72 mm. in total length, collected from the river Hooghly in November 1937.

deeper behind. The occipital process tapers to a fine point posteriorly; it is thrice as long as broad and is separated from the basal bone of the dorsal fin by a considerable distance. The mouth is slightly ascending. The lower jaw is broadly pointed in the middle and is somewhat longer than the upper. There is a pair of small maxillary barbels which lie in grooves and do not extend beyond the eyes. The teeth in the jaws are caniniform and arranged in two series in each jaw; those of the outer series invariably project beyond the mouth-opening. The teeth on the palate are villiform and are arranged in a U-shaped band.

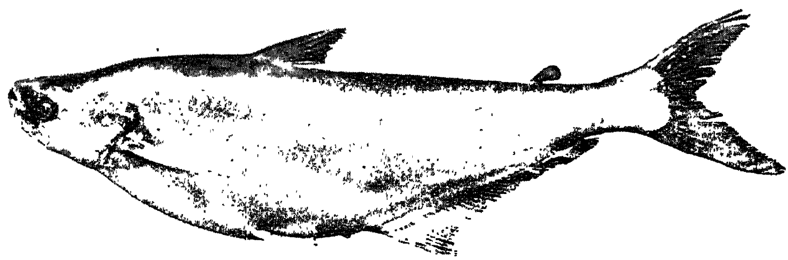
The dorsal fin is considerably, but not wholly, in advance of the ventrals; its forward position is more marked in the young than in the full-grown specimens. The dorsal spine is rather slender; it is rugose anteriorly and finely serrated posteriorly in its upper portion; it is about two-thirds the length of the head. The pectoral fin extends beyond the origin of the ventrals in young and half-grown specimens, but in larger specimens it does not reach to the base of the ventrals. The pectoral spine is similar to that of the dorsal fin. The adipose fin is small, but well-marked; it is situated above the posterior portion of the anal fin. In younger specimens it is in the posterior quarter of the length of the body, whereas in a fully mature specimen it lies in the posterior fifth of the body length. The ventrals just reach the anal opening and are separated from the anal fin by a short distance. The caudal fin is deeply forked; both the lobes are of equal length. The least height of the caudal peduncle is contained from 1·4 to 1·7 times in its length.

Colouration:—According to Hamilton (3) 'The back is of a dusky green *colour*; and, although the sides are like silver, the fish has a dirty lurid appearance, with a shade of livid hue. The back and tail fins are greenish, the others are white.' Some time after the fish is removed from water the back assumes a neutral tint while the ventral surface and sides become silvery. The opercle is shot with orange and yellow which is continued forwards to the mouth-opening. The iris is of an orange colour. The dorsal

fin is of a light neutral tint; the pectoral fin is also of the same colour but is provided with an orange band at the base. The ventrals are slightly tinted with orange. The anal fin is light purple with an orange band at the base. The adipose fin is of a purple colour. The tail fin is much darker and at the base is provided with a band of light Indian red colour.

In young specimens, below 4 inches in length, the dorsal and the pectoral fins after preservation in spirit are deeply stained with black. The posterior margin of the caudal fin and a considerable part of its superior lobe are also stained with black. These colour marks gradually fade away during growth.

Distribution:—Day in his *Fishes of India* states that this species is found in the 'Estuaries of India and Burma, ascending high up the larger rivers to nearly their sources'. The collection in the Indian Museum contains no specimen of *S. silondia* from Burma. Prof. F. G. Meggitt, at my request, sent to the Museum a collection of the local Rangoon fishes, but this species is not



Text-fig. 3.—Photograph of a large specimen of *Silonia silondia* (Ham.), 50 inches in total length, purchased from the Calcutta market.

represented in that collection. It may also be noted that Vinciguerra (8) in his account of the fishes of Burma does not record this species. It seems doubtful, therefore, whether the species is actually found in Burmese waters.[1] If, however, it occurs in Burma, it will be worthwhile to make a detailed study of the Burmese specimens and to compare them with the Indian examples

[1] Macdonald (*Journ., Bombay Nat. Hist. Soc.*, xxxiii, p. 306, 1929) records the occurrence of *Silund* (*Silundia gangetica*) in the higher reaches of the Irrawadi river.

to see the effect of isolation on them, as was found to be the case in *Eutropiichthys vacha* (Ham.) and *Clupisoma garua* (Ham.) (*vide* the second and the third articles of this series).

In South India *Silonia silondia* is replaced by the allied form *Silonopangasius*, and from the information available it seems probable that *Silonia* is restricted only to the Indo-Gangetic basin of Northern India.

As the body proportions vary considerably with growth, I give below in inches the measurements of a specimen over 4 feet in length (text-fig. 3). The measurements are only approximate.

Measurements in inches.

Total length without caudal	42·5
Length of caudal	7·5
Length of head	8·0
Length of snout	2·5
Diameter of eye	1·7
Depth of body	12·5
Length of pectoral	6·7
Length of dorsal	6·5
Length of ventral	4·5
Length of anal base	14·0
Length of caudal peduncle .	6·0
Least height of caudal peduncle	3·7
Distance between tip of snout and origin of first dorsal	15·5
Distance between tip of snout and origin of ventrals	15·5
Distance between ventrals and anal fin ...	8·0
Distance between rayed dorsal and adipose dorsal .	17·0

Bionomics and Fishing Notes.

Hamilton (3) noted that *Silonia silondia* 'is very common in the Gangetic estuaries, and is considered by the natives as good eating. It commonly grows to three feet in length, and occasionally to twice that size.' This species is a common food fish of Bengal and in the Calcutta markets large quantities of this fish are sold. The majority of the specimens, as stated by Hamilton, are below three feet in length.

It is a voracious feeder and does considerable harm to the fisheries. The young specimens, below 4 inches in length, collected from the river Hooghly were found feeding on prawns, young fish, etc. while the largest specimen examined had full-grown *Hilsa ilisha* (Ham.) in its stomach. The stomach is a large bag-like structure about twice as long as broad (text-fig. 4); the alimentary canal is only slightly convoluted. In a young specimen about 93 mm. in length, the length of the alimentary canal was about 80 mm. In a specimen 50 inches long, the stomach measured 11 inches in length and 5·5 inches in breadth. The length of the intestine was 62 inches.

Silonia silondia probably breeds in the rainy season as young specimens from three to eight inches in total length were found to be fairly common in November-December in the catches from the river Hooghly at Nawabgunge about 20 miles above Calcutta.

Measurements in millimetres.

Total length excluding caudal	54·0	100·0	108·0	135·0	144·0	155·0	200·0	203·0	330·0
Length of caudal	Damaged	26·0	28·0	32·0	31·0	45·0	48·0	41·0	Damaged
Length of head	13·0	25·0	25·0	30·0	31·0	34·0	45·0	45·0	70·0
Width of head	8·5	15·0	16·0	20·0	21·0	25·0	30·0	31·0	48·0
Width of body	6·0	10·0	12·0	16·0	16·0	20·0	25·0	26·0	42·0
Depth of body	9·6	17·0	20·0	26·0	31·0	39·0	45·0	51·0	76·0
Diameter of eye	4·0	8·0	8·0	9·0	9·0	10·0	11·0	11·0	16·0
Interorbital width	6·0	9·4	11·5	13·0	12·0	15·5	18·0	19·0	32·0
Length of snout	5·0	8·4	9·0	11·0	14·5	13·0	15·0	14·5	24·5
Length of dorsal spine	8·0	14·0	16·0	21·0	16·0	Damaged	31·0	30·0	55·5
Length of pectoral spine	10·0	18·0	20·0	23·0	23·0	27·0	35·0	35·0	56·0
Length of maxillary barbel	3·0	4·0	3·0	3·5	4·0	3·0	5·0	4·0	3·5
Length of caudal peduncle	7·0	11·0	13·0	17·0	19·0	20·0	24·0	27·0	32·0
Least height of caudal peduncle	4·5	6·5	8·0	10·0	11·5	14·5	17·0	17·5	25·0

In the list of Gorakhpur fishes Hamilton noted under *Baikar* that 'in this district it is said never to exceed six inches in length'. Presumably Hamilton was in Gorakhpur after the rainy season when the young fish are common in the river. It also seems probable that *Silonia* ascends rivers for breeding purposes and when the waters fall after the rains it becomes stranded in large pools in the upper reaches of the river. Principally it is an estuarine fish.

Text-fig. 4.—Alimentary canal of *Silonia silondia* (Ham.).

The *Silond* Catfish is a very game fish and fights well. It frequents the same type of habitats as the *Goonch*, but prefers stronger streams and clear white deep waters. The usual bait is a spoon or a fish, but specimens have also been caught on a Mahseer fly and provided good sport with this tackle also.

Though *Silonia silondia* is primarily a fluviatile fish, it can flourish in tanks and large reservoirs as well. In the Settling Tanks of the Calcutta Corporation Waterworks at Pulta the species is very common and attains a large size. It enters these reservoirs in the egg or larval stages. From a practical fisheries point of view its cultivation should be discouraged, as it is very destructive to other types of edible fishes.

ACKNOWLEDGMENTS.

The Bombay Natural History Society very kindly made a grant towards the cost of the illustrations and for this I offer my sincere thanks to the authorities of the Society. Mr. K. S. Misra, M.Sc., my assistant in the Zoological Survey of India, has helped me in the preparation of the tables of measurements and for this I am indebted to him. The illustrations were prepared by Babu B. Bagchi with his usual skill and care under my supervision.

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Explanation of Plate.

Colour sketch of the lateral view of a specimen, 214 mm. in length without caudal, of *Silonia silondia* (Hamilton) from the river Hooghly.

Immediately after the fish is taken out of water its colour is golden, but it fades quickly. The fish then becomes blue-backed with a white belly.

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INDIAN MUSEUM

Vol. XXXVIII, Part III, pp. 317—331

On a further Collection of Fish from the Naga Hills.

By

SUNDER LAL HORA

CALCUTTA:

SEPTEMBER, 1936

ON A FURTHER COLLECTION OF FISH FROM THE NAGA HILLS.[1]

By SUNDER LAL HORA, *D.Sc.*, *F.R.S.E.*, *F.N.I.*, *Assistant Superintendent, Zoological Survey of India, Calcutta.*

Early this year Dr. B. Prashad and Dr. B. Chopra paid another visit to the Naga Hills, and availed themselves of the opportunity to make a further collection of fishes. The greater part of the material, which comprises 129 specimens, was obtained from the streams of the Barail Range over which crosses the road from Imphal to Silchar, a part of the Naga Hills[2] the fauna of which had not been investigated so far.

The following are the streams of the Barail Range from which collections were made : (i) Laimatak River, 32 miles from Imphal, (ii) Irang River, 51 miles from Imphal, (iii) Khathalo stream near Nongba, (iv) Barak River between Nongba and Kalanaga, and (v) Makru River, 87 miles from Imphal. The waters from this part of the Naga Hills drain into the Barak River, which is a tributary of the Brahmaputra. From the collections before me all the streams appear to be large hill-streams with rocky beds and fairly deep waters.

Collections were also made by the Zoological Survey party at two places between Kohima and Imphal: Zekwara in the neighbourhood of Khezobama and at Karong on the ridge separating Naga Hills from the Manipur Valley. The waters from these two places drain ultimately into the Brahmaputra.

Besides, there are a few specimens, belonging to *Garra naganensis*, *Danio naganensis*, *Danio dangila*, *Psilorhynchus homaloptera* and *Nemachilus kangjupkhulensis*, of which the locality labels were torn to bits in transit and, in consequence, the precise habitat cannot now be given. Of these, *D. naganensis* and *N. kangjupkhulensis* are known only from the Chindwin drainage system and it seems likely that the party also made collections from areas whence the waters drain into the Chindwin River. *Psilorhynchus homaloptera* is known from the Brahmaputra system, *Garra naganensis* is found in both the Brahmaputra and the Chindwin systems, while *Danio dangila* is a widely distributed species.

According to the localities enumerated above the collection may be arranged as follows :—

1. Zekwara, Naga Hills. 28.i.36.

i. *Barilius bendelisis* (Ham.)	1 specimen (28 mm.).
ii. *Oreinus molesworthi* Chaudhuri	5 specimens (98-120 mm.).

2. Karong, Naga Hills. 5.ii.36.

i. *Barbus clavatus* McClell. . .	18 specimens (126-192 mm.).

[1] For a comprehensive report on the fish fauna of the Naga Hills see Hora & Mukerji, *Rec. Ind. Mus.*, XXXVII, pp. 381-404, 6 text-figs. 1 pl. (1935).

[2] It may again be pointed out that for the purpose of this paper under the name "Naga Hills" is included all the country inhabited by the Naga tribes and not merely the district to which the name is officially applied. The part of the Barail Range traversed by the party of the Zoological Survey is under the Manipur State and is inhabited by the Kacha Nagas of whom the Kabui is the predominant type.

3. Laimatak River, Imphal-Silchar Road. 8.ii.36.

i. *Pseudecheneis sulcatus* (McClell.) . .	1 specimen (171 mm.).
ii. *Barbus progeneius* McClell. . . .	1 specimen (137 mm.).
iii. *Barilius bendelisis* (Ham.) . . .	4 specimens (123-147 mm.).
iv. *Barilius barila* (Ham.)	11 specimens (105-145 mm.).
v. *Psilorhynchus homaloptera* Hora & Mukerji	1 specimen (106 mm.).

4. Irang River, Imphal-Silchar Road. 11-13.ii.36.

i. *Barbus clavatus* McClell. .	5 specimens (107-157 mm.).
ii. *Barbus progeneius* McClell.	4 specimens (107-202 mm.).
iii. *Crossochilus latius* (Ham.)	3 specimens (133-143 mm.).
iv. *Garra gotyla* (Gray) .	1 specimen (200 mm.).
v. *Barilius bendelisis* (Ham.)	1 specimen (99 mm.)
vi. *Barilius barila* (Ham.) .	16 specimens (99-162 mm.).

5. Khathalo stream near Nongba, Imphal-Silchar Road. 13.ii.36.

i. *Silurus cochinchinensis* Cuv. & Val.	2 specimens (198-200 mm.).
ii. *Barbus hexagonolepis* McClell. .	12 specimens (113-280 mm.).
iii. *Garra naganensis* Hora. . . .	2 specimens (124-126 mm.).

6. Barak River between Nongba and Kalanaga, Imphal-Silchar Road. 13.ii.36.

i. *Barbus progeneius* McClell. . . .	1 specimen (710 mm.).
ii. *Barbus tor* (Ham.)	1 specimen (491 mm.).
iii. *Labeo dyocheilus* (McClell.) . . .	2 specimens (1 complete 672 mm., one head of a still larger specimen).

7. Makru River, Imphal-Silchar Road. 18.ii.36.

i. *Barbus hexagonolepis* (McClell.) . .	6 specimens (125-183 mm.).
ii. *Garra naganensis* Hora	1 specimen (113 mm.).
iii. *Ophicephalus gachua* Ham. . . .	3 specimens (88-152 mm.).

8. Locality unknown.

i. *Garra naganensis* Hora . . .	3 specimens (72-91 mm.).
ii. *Danio* (*Danio*) *naganensis* Chaudhuri	1 specimen (*ca.* 160 mm.).
iii. *Danio* (*Danio*) *dangila* (Ham.) . .	20 specimens (25-46 mm. without caudal).
iv. *Psilorhynchus homaloptera* Hora & Mukerji	1 specimen (70 mm.).
v. *Nemachilus kangjupkhulensis* Hora .	2 specimens (55-73 mm.).

Of the 18 species represented in the recent collection 5—*Silurus cochinchinensis*, *Pseudecheneis sulcatus*, *Labeo dyocheilus*, *Barbus progeneius* and *Garra gotyla*—are recorded from this area for the first time. The last species was, however, obtained by Dr. Murray Stuart (Hora, *Rec. Ind. Mus.*, XXII, p. 743, 1921) from the North-eastern border of Burma and the Naga Hills, but it can now be definitely included in the fauna of the latter district. The range of *S. cochinchinensis* extends from the Eastern Himalayas (below Darjeeling) through Assam hills and Burma to Cochin China, Fukien and Hainan. *Pseudecheneis sulcatus* is found in Assam and Northern Burma and westwards its range extends to the Darjeeling Himalayas. *Labeo dyocheilus* was described from the Brahmaputra in Assam but since then it has been recorded from Hardwar, Simla and the Sind hills. *Barbus progeneius* was described from the Brahmaputra but its identity had been confused with *B. tor*. *Garra gotyla* is found along the Himalayas from the Dehra Dun hills to Assam and Burma.

Including the collection under report, the fish fauna of the Naga Hills comprises 49 species distributed among the following families: 2 to Siluridae, 1 to Bagridae, 1 to Amblycepidae, 4 to Sisoridae, 24 to

Cyprinidae, 2 to Psilorhynchidae, 11 to Cobitidae, 1 to Mastacembelidae, 1 to Nandidae and 2 to Ophicephalidae.

Though most of the species represented in the collection do not call for any comments, it has been possible to elucidate the chief distinguishing features of the large-scaled Barbels of Assam—*B. hexagonolepis*, *B. tor* (=*B. hexastichus*), *B. putitora* and *B. progeneius*. The study of a large specimen of *Labeo dyocheilus* has also enabled me to clear up the specific identity of this species and to distinguish it from the allied *L. dero*. The Burmese and Siamese specimens of *L. dero* are separated into a distinct species **L. devdevi,** sp. nov. Further it is shown that Mukerji's "Assamese and Burmese form" of *Crossochilus latius* is restricted to the Burmese drainage systems and that in the parts of Assam drained by the Brahmaputra only the typical form of the species is found. In view of the structural differences between the two forms and their restricted ranges of distribution the name **burmanicus** is proposed here for the Burmese form. Observations are also offered regarding variation in structure or colouration of *Silurus cochinchinensis* and *Pseudecheneis sulcatus*. The record of *Psilorhynchus homaloptera* from a different part of the Naga Hills is also of special interest, as it shows that the species is not strictly localised in its distribution.

The following vernacular names were noted down by the party:—

1. *Khotavu* Angami: *Oreinus molesworthi* Chaudhuri.
2. *Kha suang: Pseudecheneis sulcatus* (McClell.).
3. *Tau pompoi: Psilorhynchus homaloptera* Hora & Mukerji.
4. *Them ga: Barilius bendelisis* (Ham.) and *B. barila* (Ham.).
5. *Kha goi: Barbus clavatus* McClell.

Kha means fish corresponding with the Burmese *Nga*. *Tau* means stone and *pompoi* means 'to stick to', *Tau pompoi* is thus a very appropriate name for *Psilorhynchus homaloptera*. *Goi* means 'serrated like a saw', thus *Kha goi* means a fish with the dorsal spine serrated like a saw, a very significant name for *Barbus clavatus*. These fish names indicate the great familiarity of the local people both with the habits and structures of the fishes inhabiting their part of the Naga Hills.

SILURIDAE.

Silurus cochinchinensis Cuvier & Valenciennes.

1920. *Silurus cochinchinensis*, Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 171.

Khathala stream near Nongba, Imphal-Silchar Road. 13.ii.36.

Silurus cochinchinensis is represented by two adult specimens, about 200 mm. in total length, in the recent collection of fish from the Naga Hills. In this species there are only two mandibular barbels and, in consequence, it is placed in the genus *Parasilurus* Bleeker by certain ichthyologists. Day[1] and Günther[2], however, did not attach much importance to this character and their contention is now fully borne

[1] Day, *Fish. India*, p. 481 (1877).

[2] Günther, *Cat. Fish. Brit. Mus.*, V, p. 32 (1864).

out by the discovery of 3 pairs of barbels[1] in the young stages of *Silurus asotus* Linn., the genotype of *Parasilurus*. In the course of growth, however, one pair of mandibular barbels is absorbed.

Usually there are 2 to 4 soft rays in the dorsal fin which, in the case of well preserved specimens, are invariably enveloped in thick skin. In both the specimens under report the dorsal fin is totally absent and no vestige of it can be made out externally. It would thus appear that no taxonomic value can be attached to the presence or absence of a vestigial dorsal fin in the case of Silurid fishes.

S. cochinchinensis was originally described from Cochin China, but it has since been found in Burma, Assam, and Darjeeling Himalayas towards the west and in Hainan and Fukien towards the east. It is a small species growing to about 8 or 9 inches in length.

SISORIDAE.

Pseudecheneis sulcatus (McClelland).

1923. *Pseudecheneis sulcatus*, Hora, *Rec. Ind. Mus.*, XXV, p. 44.

Laimatak River, Imphal-Silchar Road. 8.ii.36.

Only one example of *Pseudecheneis sulcatus*, 171 mm. in total length, was collected by Drs. B. Prashad and B. Chopra in their recent visit to the Naga Hills. It corresponds with specimens from other localities, except that it is much darker in colour and the lighter bands across the back are fewer and shorter.

The range of the species extends from the Darjeeling Himalayas and the Assam hills to Upper Burma.

CYPRINIDAE.

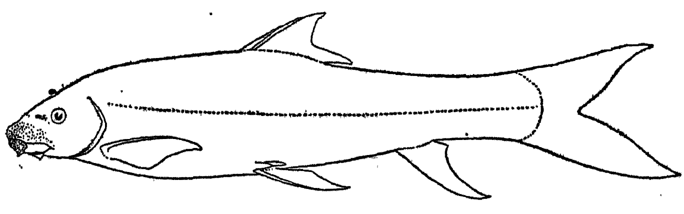
Labeo dyocheilus (McClelland).

1839. *Cyprinus (Labeo) dyocheilus*, McClelland, *As. Res.*, XIX, pp. 268, 330, pl. xxxvii, fig. 1.

1877. *Labeo dyocheilus*, Day, *Fish. India*, p. 540, pl. cxxx, fig. 1.

Barak River between Nongba and Kalanaga, Imphal-Silchar Road. 13.ii.36.

Labeo dyocheilus and *L. dero* (Ham.). are similar in several features and as their respective ranges of distribution more or less coincide they



TEXT-FIG. 1.—Lateral view of a stuffed specimen of *Labeo dyocheilus* (McClelland). $\times \frac{2}{15}$.

are liable to be confused with each other. Though the original accounts of the species are inadequate for the determination of their precise specific

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[1] Atoda, *Doutsugaku Zasshi*, XLVII, p. 228, (1935) [text in Japanese]; Kimura, *Journ. Shanghai Sci. Inst.*, sec. 3 III, p. 105 (1935).

limits, the specimens referred by Day to the two species and now preserved in the collection of the Indian Museum show that he was familiar with the differences between them. According to Day's descriptions, the two species may be differentiated as follows :

"*Labeo diplostomus*"[1] (*L. dero*).	*Labeo dyocheilus.*
i. 6-7 rows of scales below lateral line to base of ventral.	5 rows of scales below lateral line to base of ventral.
ii. Length of head 5½-6¼, height of body 5-5½ in total length.	Length of head 5-5½, height of body 3¾ to 4½ in total length.
iii. Diameter of eye 5-6½ in length of head, 2½-3 in interorbital width.	Diameter of eye 6-9 in length of head, 3½-5 in interorbital width.
iv. Snout with a groove and without lateral lobes.	Snout without a groove[2] and with distinct lateral lobes.
v. Mouth rather narrow . . .	Mouth wide.
vi. Upper margin of dorsal deeply concave in the adult.	Upper margin of dorsal slightly concave in the adult.
vii. Pectoral does not extend to ventral, nor the latter to anal.	Pectoral reaches ventral, and the latter base of anal.

I have studied these differences in reference to the material in the Indian Museum and find that the proportions of various parts vary considerably with age in both the species, except that the interorbital space is relatively much broader and the eyes smaller in *L. dyocheilus* than in *L. dero*. The number of scales below the lateral line is also a good diagnostic character for distinguishing the two species. The nature of the snout offers a useful character, especially in adults. In *L. dyocheilus* the front part of the snout, dorsally, laterally and ventrally, is studded with pearl organs or spiny tubercles, whereas in *L. dero* they are, when present, fewer in number and totally absent from the ventral surface of the head. Along with the appearance of large pearl organs a deep groove is developed on the snout of *L. dero*, especially in the males. The prolongation of the anterior dorsal rays in *L. dero* is also associated with the development of the pearl organs in the males, while in *L. dyocheilus* there is no such correlation. It is thus seen that marked sexual dimorphism is also a feature of *L. dero*. Reference may here be made to an interesting case of sexual dimorphism found by Mukerji and myself[3] in the case of *Barbus chagunio* (Ham.).

The examination of a large series of specimens has shown that the two species can be readily distinguished by the nature of the dorsal surface of the free portion of the lower lip. In *L. dero*, as indicated already,[4] this surface is studded with large tubercles, whereas in *L. dyocheilus* there are series of ridges instead of tubercles or papillae. This difference in the structure of the lower lip is noticeable both in the young and adult specimens of the two species.

McClelland remarked that his *L. dyocheilus* "is found in the clear active currents of the Brahmaputra from Middle Assam to the rapids at

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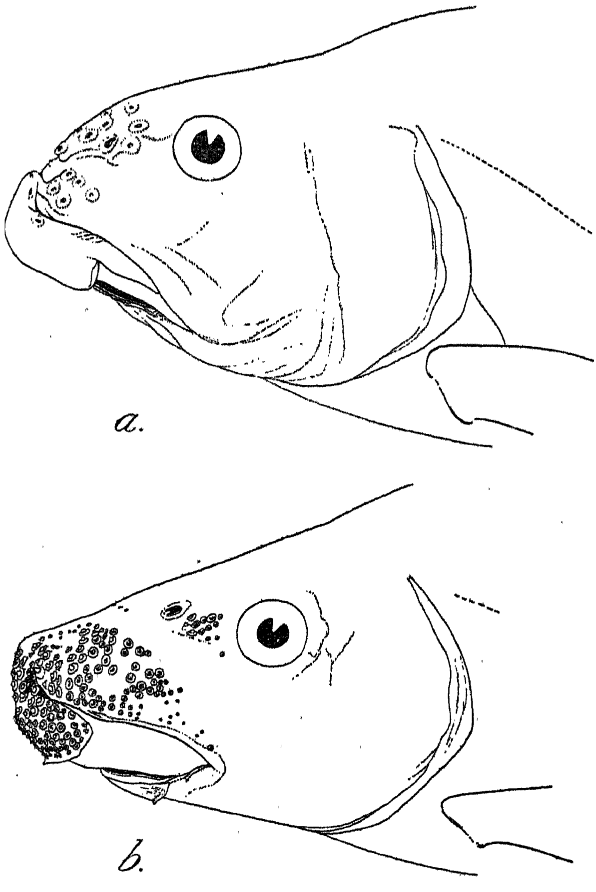
[1] All the specimens determined by Day as *L. diplostomus* and now preserved in the collection of the Indian Museum are referable to *L. dero* (Ham.).

[2] Day noticed a Sind specimen with a depression across the snout.

[3] Hora & Mukerji, *Journ. As. Soc. Bengal* (N. S.) XXVII, pp. 137-139 (1933).

[4] Hora & Mukerji, *Rec. Ind. Mus.*, XXXVIII, p. 142 (1936).

the extremity of the valley, but appears to be equally unknown in mountain torrents, and sluggish rivers and jeels in the plains." This indicates that the species is to be found in deeper parts of swift flowing rivers, like the Brahmaputra. Drs. Prashad and Chopra obtained the

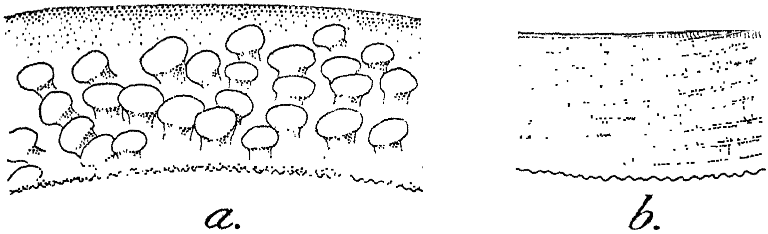


TEXT-FIG. 2.—Lateral view of head and anterior part of body of *Labeo dero* (Ham.) and *Labeo dyocheilus* McClelland, showing general form of head and arrangement of tubercles.

a. Labeo dero (Ham.). *ca.* Nat. size; *b. Labeo dyocheilus* (McClell.). × *ca.* ½.

two specimens noted above in similar situations in the Barak River. *L. dero*, on the other hand, is found at the sides of torrential streams in shallow waters and is caught in large numbers with the help of cast nets. Probably on account of these differences in the habitats of the two species, we find that *L. dero* is well represented in Museum collections whereas *L. dyocheilus* is rather rare. Both the species are of great economic importance, *L. dero* growing to a length of about 18 inches and *L. dyocheilus* to 3 feet or more. The largest specimen of the former in the collection of the Indian Museum is 17 inches and of the latter 26 inches.

Mukerji's[1] observations on *L. dyocheilus* were unfortunately based on inadequate material in the collection of the Indian Museum which then consisted of only three specimens, one from Simla, one from Hardwar, and one from the Abor Hills, Assam.[2] As the species was



TEXT-FIG. 3.—A portion of dorsal surface of the free lower lip of *Labeo dero* (Ham.) and *Labeo dyocheilus* (McClell.). × 61.
a. Labeo dero (Ham.); *b. Labeo dyocheilus* (McClell.).

originally described from Assam, Mukerji regarded the Assamese specimen as *forma typica* and remarked: "These two specimens from the Western Himalayas do not appear to me to represent the true *L. dyocheilus* so far as I am able to judge by comparison with the Abor specimen, which I consider to be the typical form of *L. dyocheilus*. It seems probable that the Western Himalayan form of the species is distinct." In conformity with the conclusions recorded above specimens received from the Darjeeling Himalayas were referred by Mukerji and myself to the typical form of *L. dyocheilus*.

The presence of two large specimens of *L. dyocheilus* in the collection under report made me examine the previous material once again and it was found that the Simla and Hardwar specimens represent *Labeo dyocheilus*, while all the other specimens from the Darjeeling Himalayas, Assam, Burma and Siam are referrable to the allied species *L. dero* and its Burmese form. Of the typical *L. dero* Mukerji and I[3] had recently collected a large number of specimens in the Dehra Dun hills. The four specimens of *L. dyocheilus* seem to agree in almost all particulars, but as they greatly differ in size no real comparison can be made between them.

The position with regard to *L. dero* is different. This species is represented by a large number of specimens collected from the Ganges and the Brahmaputra drainage systems and from the Burmese drainage systems. There are two specimens from the Kashmir Valley also. The differences noted by Mukerji in the Eastern Himalayan and Assamese specimens (Brahmaputra drainage) and the Burmese and Siamese specimens show that here again we have a condition similar to that of *Crossochilus latius* (*vide infra*) and it seems advisable to regard the two forms as distinct species. The Burmese and the Siamese form which differs from the typical specimens of *L. dero* in having a somewhat shorter head, bluntly rounded snout with the depression across it less

[1] Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, pp. 55-59 (1934).
[2] Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 249 (1913).
[3] Hora & Mukerji, *Rec. Ind. Mus.*, XXXVIII, p. 142 (1936).

marked, 40-41 scales along the lateral line and 13 in a transverse series between the bases of the dorsal and ventral fins (*versus* 40-44 along the lateral line and 16-17 rows between the bases of the dorsal and ventral fins) and 19-21 scales round the caudal peduncle (*versus* 22-23) may be called **L. devdevi**, thus associating its name with that of Mr. Dev Dev Mukerji who first noticed these differences.

The Kashmir specimens seem to differ from both *L. dero* and *L. devdevi*, but the material is not sufficient to discuss their true relationships. They had better be kept separate as *L. diplostomus* (Heckel)[1] for the time being.

Crossochilus latius (Ham.).

1934. *Crossochilus latius (forma typica)*, Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, p. 52.

Irang River, Imphal-Silchar Road. 13.ii.36.

The specimens of *Crossochilus latius* hitherto collected from Assam (Manipur Valley[2]; Tizu River, Naga Hills[3]) have been referred to the Assamese and Burmese form as recognised by Mukerji (*op. cit.*). The three specimens recently collected from the Naga Hills, however, belong to the typical form known from the Brahmaputra[4] and the Gangetic[5] drainage of the Himalayas. It would thus appear that the term "Assamese form" is ambiguous, for within the political limits of Assam both the forms are met with. When, however, the distribution of the two forms is considered with regard to the various drainage systems, it is found that the *forma typica* is restricted to the Brahmaputra and the Gangetic systems, whereas the form **burmanicas** (this new specific name is proposed for the Assamese and Burmese form of Mukerji) is found in the various drainage systems of Burma—the Chindwin, the Irrawadi[6], the Salween[7], etc.[8]. The two forms differ mainly in their lepidosis and the relative length of the head. Even superficially they appear to be quite distinct, and it seems desirable to denote them by different names, as has been done already by Mukerji[9] for the Punjab form.

LARGE-SCALED BARBELS OF ASSAM.

In Bengal and Assam the vernacular names *Mahasaula, Mahaseer, Tora,* etc., in which reference is made to the large size of the head or scales, are indiscriminately applied to several species of large-scaled Barbels which are usually confined to the rapid and clear currents of the larger rivers at the bases of mountains. The confusion has become worse on account of the sportsmen having either adopted local names

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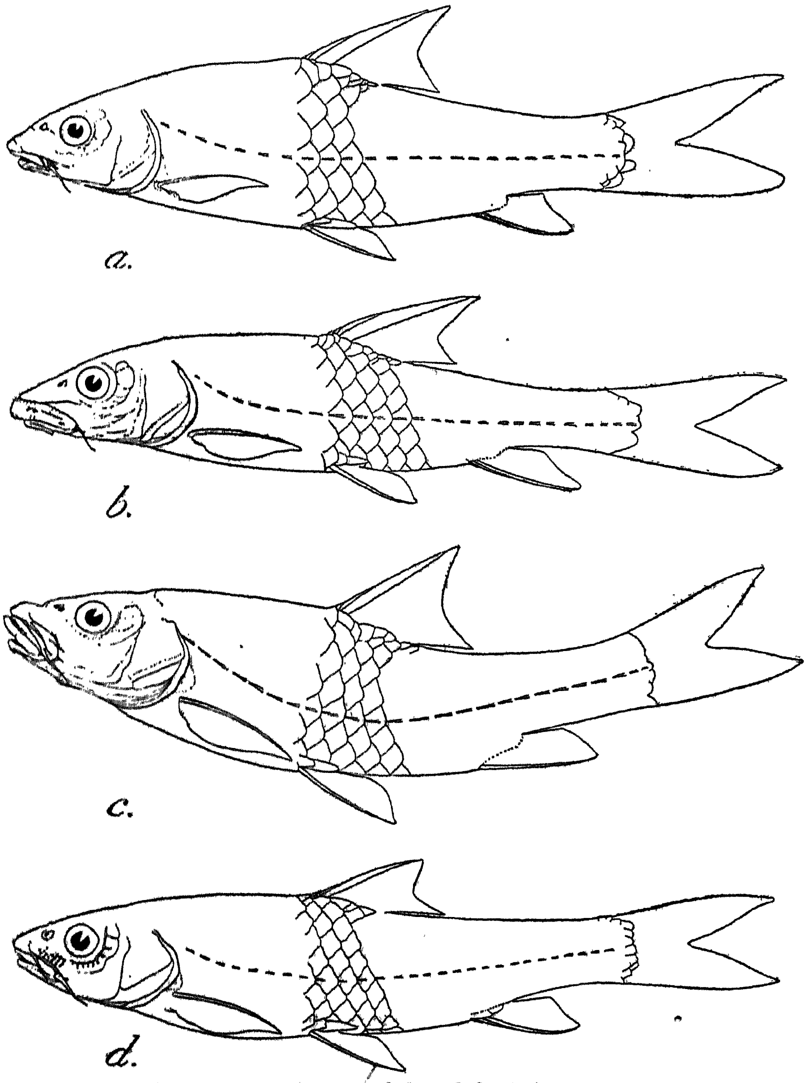
[1] Mukerji, *Mem. Connecticut Acad. Arts. & Sci.*, X, p. 329 (1936).
[2] Hora, *Rec. Ind. Mus.*, XXII, p. 183 (1921).
[3] Hora & Mukerji, *Rec. Ind. Mus.*, XXXVII, p. 389 (1935).
[4] Hamilton, *Fish. Ganges*, p. 345 (1822).
[5] Hora & Mukerji, *Rec. Ind. Mus.*, XXXVIII, p. 143 (1936).
[6] Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, p. 52 (1934).
[7] Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 280 (1890).
[8] Mukerji, *Rec. Ind. Mus.*, XXXIV, p. 283 (1932).
[9] Mukerji, *Mem. Connecticut Acad. Arts & Sci.*, X, p. 331 (1936).

or called their catches representing various species as *Mahseer*. Unfortunately, the ichthyologists, not having sufficient material of the various forms at one place for examination, have also thought it convenient to lump together several forms under *Barbus tor*. Recently Mukerji and



TEXT-FIG. 4.—Large-scaled Barbels of Assam.

a. Lateral view of a young specimen of *Barbus tor* (Ham.). × ½.
b. Lateral view of a young specimen of *Barbus putitora* (Ham.). × ½.
c. Lateral view of a young specimen of *Barbus progeneius* McClelland. × ½.
d. Lateral view of a young specimen of *Barbus hexagonolepis* McClelland. × ½.

The number of scales along the lateral line, the lepidosis between the bases of the dorsal and pelvic fins and also the nature of the last dorsal spine are shown in each case. The above characters help to differentiate these closely allied species.

I[1], as a result of field observations in the Dehra Dun hills and an examination of a large material in fresh condition, were able to define the specific limits of the three species of such carps described by Hamilton in his *Gangetic Fishes*—*B. putitora*, *B. mosal* and *B. tor*. The material brought back by Drs. Prashad and Chopra from the Naga Hills now affords an opportunity to discuss the identity of the forms described by McClelland from Assam.

In his "Indian Cyprinidae" McClelland recognised 5 species of large-scaled Barbels, *viz.*, *Barbus hexastichus* (=*Cyprinus tor* Ham.), the *Lobura* of the Assamese; *B. progeneius*, the *Jungha* of the Assamese; *B. macrocephalus*, the *Burapetea* of the Assamese; *B. hexagonolepis*, the *Bokar* of the Assamese and *B. megalepis* (=*Cyprinus mosal* Ham.). The first 4 species were studied in the field either by Griffith or McClelland himself and large series of each seem to have been examined. Of *B. megalepis* McClelland observes:

> "The only specimen of this species I have seen is contained in a small collection of fishes presented to the Society by Mr. Hodgson. Its principal difference from the last described [*B. hexagonolepis*] consists in its having a longer head, which is narrower and more compressed at the snout."

The *Mosal* was found by Hamilton in the Kosi River and McClelland surmises that Mr. Hodgson's specimen also came from the same area.

Regarding Hamilton's *Cyprinus putitora*, McClelland made the following observations under *B. hexagonolepis*:

> "There is still another large species *Cyp. pitutora*, Buch. closely allied to the preceding Barbels, which according to Buchanan attains nine feet in length; it has the following rays in its fins,
>
> D. 11 : P. 15 : V. 9 : A. 7 : C. 19.
>
> The head is said to be blunt, oval, and small, with a protractile mouth, and the scales to terminate with a notch behind. The first of these characters would seem partly to refer it to *B. hexagonolepus*, while the notch at the apex of the scales is only apparent in *B. macrocephalus*. There is no drawing in Buchanan's collection of the species alluded to, and as his description is not sufficiently clear, we must for the present consider *Cyp. pitutora* as a doubtful species."

Barbus tor (Hamilton).

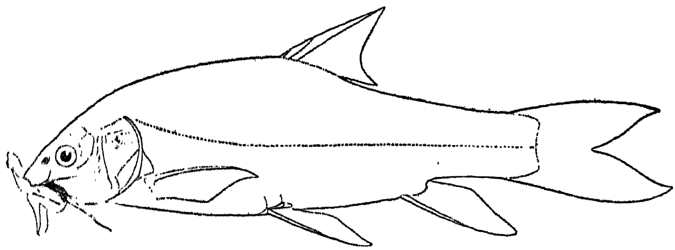
1922. *Cyprinus tor*, Hamilton, *Fish. Ganges*, pp. 305, 388.
1839. *Barbus hexastichus*, McClelland, *As. Res.*, XIX, pp. 269, 333, pl. xxxix, fig. 2.
1936. *Barbus tor*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVIII, p. 139.

Barak River between Nongba and Kalanaga, Imphal-Silchar Road. 13.ii.36.

In the collection under report *Barbus tor* is represented by a single specimen about 49 cm. in length. Mukerji and I (*op. cit.*) have already referred to the distinguishing features of this species, *i.e.*, the red colour of its fins when alive (a character referred to by McClelland also: "with the tips of fins a more decided red"); small head, shorter than depth of body (about 4 or more than 4 times in total length without the caudal) and deeper body (its height being less than 4 times in the total length without the caudal). In the young or half-grown specimens that I had

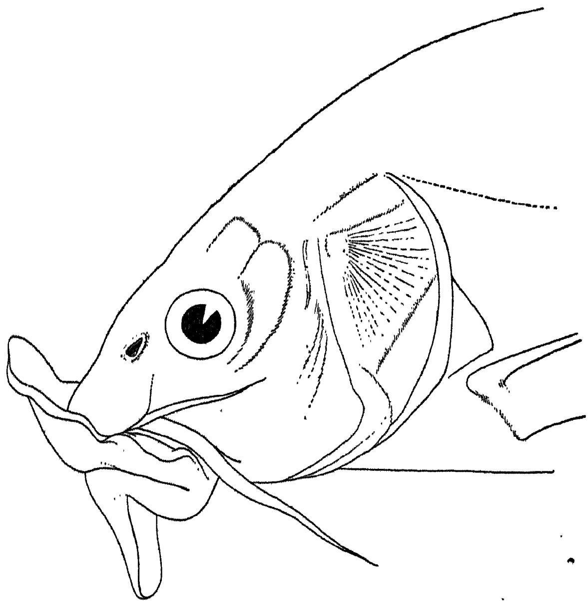
[1]Hora & Mukerji, *Rec. Ind. Mus.*, XXXVIII, pp. 139—142 (1936).

hitherto examined, the lips were of the normal type, without any pendulous lobes, but in the specimen from the Barak River both the lips are reflected backwards throughout their extent and produced into broad lobes in the middle. Neither Hamilton nor McClelland noticed such



Text-fig. 5.—Lateral view of a spirit specimen of *Barbus tor* (Ham.). $\times \frac{2}{11}$.

a condition of the lips in this species. Day[1] figured a specimen as *B. tor* from South India (Canara or Malabar) in which the condition of the lips corresponds with the specimen from the Barak River. In Day's figure the height of the body is almost equal to the length of the head which



Text-fig. 6.—Lateral view of head and anterior part of body of the specimen illustrated in text-figure 5, showing the nature of the hypertrophied upper and lower lips. $\times \frac{3}{5}$.

is not the case with the Assamese example. It seems very probable that in the Peninsula the species is represented by a relatively slender form.

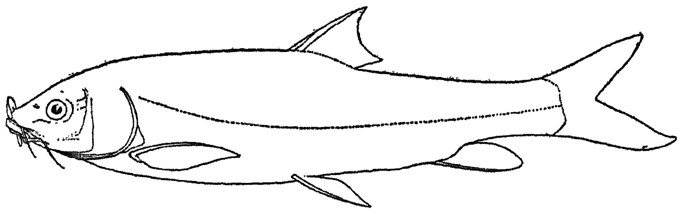
[1] Day, *Fish. India*, pl. cxl, fig. 1 (1877).

McClelland observes that the figure of this species in Buchanan's collection of Ms. Drawings refers to *B. progeneius* and not to this species. The drawing referred to is 121 of volume IV of the Ms. drawings[1]. From the nature of the dorsal spine, which is very hard, bony and long, and the red colouration of the distal parts of the pectoral, ventral and anal fins it seems almost certain that the species figured is *B. tor* and not *B. progeneius*. The figure is, however, inaccurate in so far as the size of the head is concerned. A small lobe of the lower lip is shown in the figure, but such a structure is found in several species, including *B. tor* though McClelland observed it only in his *B. progeneius*.

Barbus progeneius McClelland.

1839. *Barbus progeneius*, McClelland, *As. Res.*, XIX, pp. 270, 334, pl. lvi, fig. 3.
Laimatak River, Imphal-Silchar Road. 8.ii.36.
Irang River, Imphal-Silchar Road. 11-13.ii.36.
Barak River between Nongba and Kalanaga, Imphal-Silchar Road. 13.ii.36.

In characterising *Barbus progeneius*, McClelland was greatly influenced by the character of the lower lip which, in the adult, is produced



TEXT-FIG. 7.—Lateral view of a stuffed specimen of *Barbus progeneius* McClelland. × 1/8.

into a median, fleshy lobe. As this character is common to *B. tor* (*vide supra*), *B. putitora*, and certain South Indian forms, this species has not usually been recognised as distinct. In the present collection from the Naga Hills there are 6 specimens ranging in length from 113 to 710 mm. which represent *B. progeneius* and it is now possible to give the distinguishing features of this species.

McClelland defined the species as follows :—

"Length of the head to that of the body as one to three ; scales large and rounded, posteriorly ; twenty-six along each lateral line, and six from the base of each ventral to the dorsum. Fins short. The number of rays are,

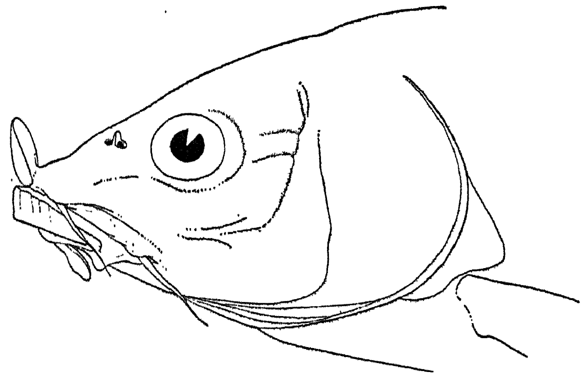
D. 12 : P. 16 : V. 9 : A. 7 : C. 19.

The head is long and much compressed, the mouth is narrow and small, and from the lower lip a fleshy appendix is extended, by which it is distinguished from the neighbouring species."

The long, compressed head and short fins are very characteristic of *B. progeneius*. The dorsal spine is less developed than in *B. tor*. The length of the head is almost equal to the depth of the body. In adult specimens the median lobe of the lower lip is reflected backwards and the middle portion is produced into a tongue-like flap. The tip of the

[1] Hora, *Mem. Ind. Mus.*, IX, p. 189 (1929). There is also another unfinished drawing (No. 125a) of the same species ; this seems to have been added later on. This drawing was published by Gray in his *Illustrations of Indian Zoology*, II, pl. xcvi, fig. 1 (1830-34).

snout is fleshy and produced into a more or less circular flap. The upper lip is fleshy but not produced as in *B. tor.*

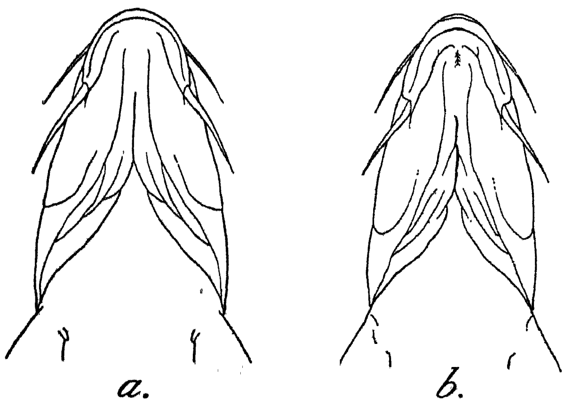


Text-fig. 8.—Lateral view of head and anterior part of body of the specimen illustrated in text-figure 7, showing the nature of the hypertrophied snout and lower lip. $\times \frac{2}{3}$.

Note.—The upper lip is fleshy, but not hypertrophied.

In the shape of the head this species shows considerable resemblance to *B. putitora*, but the form of the latter is more graceful (height of body considerably less than length of head), the dorsal spine more bony, the head relatively longer, the snout more blunt and the eyes proportionately smaller. The median lobe of the lower lip is well developed even in the young of *putitora.*

In its weak dorsal spine *B. progeneius* resembles *B. hexagonolepis*, but besides the hexagonal form of the exposed surfaces of the scales



Text-fig. 9.—Ventral surface of head and anterior part of body of *Barbus progeneius* McClelland and *Barbus hexagonolepis* McClelland. *Nat. size.*
a. Barbus hexagonolepis McClell.; *b. Barbus progeneius* McClelland.

the latter possesses a widely interrupted labial groove, about 28 scales along the lateral line and 7 between the bases of the dorsal and ventral fins (against 26 along the lateral line and 6 between the bases of the dorsal and ventral fins in *B. progeneius*) and the barbels longer than the diameter of the eye. In the young of *B. progeneius* there is a black streak

behind the gill-openings, but the general body colour is lighter than that of *B. hexagonolepis*.

The alimentary canal is only 1·3 times as long as the fish and this shows that it is more or less a carnivorous species.

Barbus putitora (Hamilton).[1]

1822. *Cyprinus putitora*, Hamilton, *Fish. Ganges*, pp. 303, 388.
1822. *Cyprinus mosal*, Hamilton, *ibid.*, pp. 306, 388.
1839. *Barbus macrocephalus*, McClelland, *As. Res.*, XIX, pp. 270, 335, pl. lx, fig. 2.
1839. *Barbus megalepis*, McClelland, *ibid.*, pp. 271, 337.
1936. *Barbus putitora*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVIII, p. 141.

So far no specimen of this species seems to have been collected from the Naga Hills, but McClelland's account of *Barbus macrocephalus* shows that the fish is fairly common in the rapids of Assam. Mukerji and I referred to the distinguishing features of this species as compared with *B. tor* and I have pointed out above the differences between *B. progeneius* and *B. putitora*. Its long head, narrow body and strong dorsal spine are some of its principal diagnostic features.

In the form of the scales McClelland noticed the resemblance between his *B. macrocephalus* and *B. putitora*. On the authority of Griffith it was pointed out by McClelland regarding this species and "another fish very nearly allied to it, called by the natives *Mahaseer*, that they are extremely voracious and carnivorous in their habits as to swallow any of the smaller fishes that approach them." From an examination of the viscera of *B. putitora* Mukerji and I also concluded that this species is more carnivorous and voracious than *B. tor*. In the Dehra Dun hills the chief bait for *B. putitora* is *Barilius bendelisis* and *Labeo dero*, so it appears evident that the fish feeds on smaller species. *B. putitora* is probably widely distributed in the submountainous streams of the Himalayas and the Assam hills.

Barbus hexagonolepis McClelland.

1839. *Barbus hexagonolepis*, McClelland, *As. Res.*, XIX, pp. 270, 336, pl. xli, fig. 3.
1936. *Barbus hexagonolepis*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVII, p. 389.
Khathalo stream near Nongba, Imphal-Silchar Road. 13.ii.36.
Barak River between Nongba and Kalanaga, Imphal-Silchar Road. 13.ii.36.

This is probably the commonest Barbel of the torrential streams of the Naga Hills. The relatively smaller scales (28-30 along the lateral

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[1] McClelland (*op. cit.*, p. 271, foot-note) considered *Barbus putitora* (Ham.) as a variety of his *B. hexagonolepis* and remarked: "This fish I have been unable to identify with Buchanan's description, I may therefore have described it under another name; he says the head is blunt, oval, small, and smooth, which scarcely applies to either of the foregoing [*B. progeneius* and *B. macrocephalus*], in which the head is remarkably lengthened; that of *B. hexagonolepis* would come nearest to it, though some of the others seem to correspond more in other respects with the account given. Pisc. Gang. 303." Hamilton's description of the head of *B. putitora* as "blunt, small, and smooth with a very minute *tendril* at each corner of the mouth, and another from each side of the under jaw" is rather unfortunate and seems to have been responsible for the confusion in the identity of the largest of the Indian Carps. It appears probable, however, that the above description referred to the snout and not to the head as a whole. Any how there can be little doubt now about the precise specific limits of *putitora* (*vide* Hora & Mukerji, *op. cit.*, 1936).

line and 7 between the bases of the dorsal and ventral fins), shorter and rounded head covered with tubercles on the sides, relatively shorter pectoral and ventral fins and weak dorsal spine are its principal characteristic features. McClelland distinguished it by the hexagonal outline of the exposed parts of its scales.

McClelland observes on the authority of Griffith that *B. hexagonolepis*

> "is to be found in all large rivers on the Eastern frontier, from the base of the mountains to the situation at which the currents first become languid in the plains, keeping mostly in the middle of the stream, where it takes a red hackle very freely, as well as worms and other bait. It is very powerful, often attaining two feet and upwards in length, and usually weighing from eight to twelve pounds."

The alimentary canal is short, about 2 to 2·2 times the length of the fish. As pointed out by McClelland the intestine of this species is of great capacity. The fish seems to be predacious in its habits feeding on insect larvae and small fish.

ADDENDUM.

After the above article had been sent to the press I found among the undetermined material in the Indian Museum another small collection of fish from the Naga Hills made by Mr. C. McCann of the Bombay Natural History Society in February 1930. It comprises 52 specimens belonging to 10 species. Of these 51 specimens were collected from pools in the bed of a rocky stream at Chang Chang, while one specimen of *Ophicephalus gachua* was obtained from a muddy tank at Chareli. The waters of these parts of the Naga Hills drain into the Brahmaputra system.

The following species are represented in this material :—

BAGRIDAE.	
1. *Mystus bleekeri* (Day) . .	2 specimens.
OLYRIDAE.	
2. *Olyra longicaudata* McClelland .	5 specimens.
CYPRINIDAE.	
3. *Danio dangila* (Ham.) . .	7 specimens.
4. *Danio aequipinnatus* McClelland .	14 specimens.
5. *Barbus* sp. (Juv., Mahseer type)	2 specimens.
6. *Barbus* sp. (Juvenile specimens) .	3 specimens.
7. *Barbus ticto* (Ham.) . . .	3 specimens.
NANDIDAE.	
8. *Badis badis* (Ham.) . . .	12 specimens.
OPHICEPHALIDAE.	
9. *Ophicephalus punctatus* Bloch. .	1 specimen.
10. *Ophicephalus gachua* Ham. .	3 specimens.

The only species new to the fauna of the Naga Hills is *Olyra longicaudata* which was originally described from the Khasi Hills. I[1] have pointed out elsewhere that *O. elongata* Günther[2] and *O. kempi* Chaudhuri[3] are to be regarded as synonyms of this species. *O. longicaudata*, thus defined, is found in the Darjeeling Himalayas, the hills of Assam and Tenasserim.

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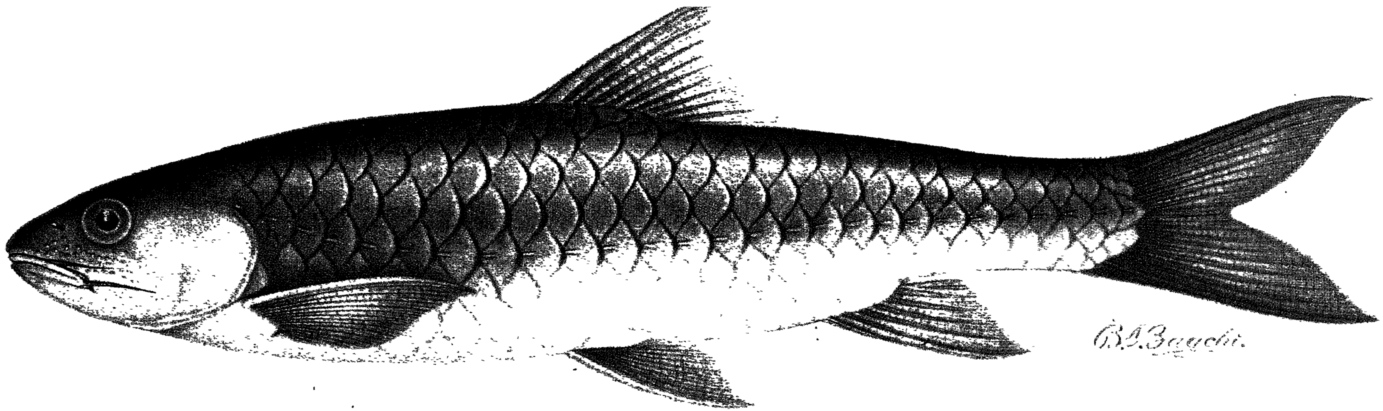
[1] Hora, *Rec. Ind. Mus.*, XXXVIII, p. 207 (1936).
[2] Günther, *Ann. Mag. Nat. Hist.*, (5), XI, p. 139 (1883).
[3] Chaudhuri, *Rec. Ind. Mus.*, VII, p. 443 (1912).

THE GAME FISHES OF INDIA.

XI. The Mahseers or the Large-scaled Barbels of India.

4. The Bokar of the Assamese and Katli of the Nepalese, *Barbus (Lissochilus) hexagonolepis* McClelland.

By Sunder Lal Hora, D.Sc., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I. (*With one colour plate and four text-figures*).



The Bokar of the Assamese and Katli of the Nepalese,
BARBUS (LISSOCHILUS) HEXAGONOLEPIS McClelland.

[From the JOURNAL OF THE BOMBAY NATURAL HIST. SOC., December 1940.]

THE GAME FISHES OF INDIA.[1]

BY

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Assistant Superintendent, Zoological Survey of India, Calcutta.

(*With one colour plate and four text-figures*).

(*Continued from page 794 of Vol. xli, No. 4*).

XI.—THE MAHSEERS OR THE LARGE-SCALED BARBELS OF INDIA.

4. THE BOKAR OF THE ASSAMESE AND KATLI OF THE NEPALESE, *Barbus* (*Lissochilus*) *hexagonolepis* McClelland.

CONTENTS.

INTRODUCTION.

After Hamilton (**3**, pp. 303-307)[2], McClelland (**10**, pp. 333-338) in his account of the Indian Cyprinidæ dealt with the large-scaled barbels of India and described 5 species, *viz.*, *B. hexastichus*, *B. progeneius*, *B. macrocephalus*, *B. hexagonolepis*, and *B. megalepis*. The first four were described from Assam, while the last species was obtained in the river Kosi. As McClelland's descriptions are brief and inadequate, and his illustrations inaccurate, an attempt was made in an earlier paper (**7**, pp. 324-331) to define the specific limits of his species, but in the absence of authentic material from Assam, the conclusions reached could only be tentative. With a view to study good series of specimens from Assam, a short visit was paid to the Darrang District in November 1939, and the fish fauna of the Brahmaputra and some of its tributary streams

[1] Published with permission of Director, Zoological Survey of India.
[2] Numerals in thick type within brackets refer to the serial numbers of the various publications listed in the bibliography at the end of the paper.

was investigated. Unfortunately, examples of only two species of the large-scaled barbels were obtained, and the systematic position of the remaining forms, therefore, still remains uncertain. For the sake of convenience of reference, I give below in a tabular form the conclusions reached so far regarding the identity of McClelland's five species:

McClelland's determination	Assamese name.	Present position.
1. *Barbus hexastichus*, pl. 39, fig. 2.	*Lobura.*	*Barbus (Tor) tor* (Ham.).
2. *Barbus progeneius*, pl. 56, fig. 3.	*Jungha.*	*Barbus (Tor) progeneius* McClelland.
3. *Barbus macrocephalus*, pl. 55, fig. 3.	*Burapetea.*	*Barbus (Tor) putitora* (Ham.)
4. *Barbus hexagonolepis*, pl. 41, fig. 3.	*Bokar.*	*Barbus (Lissochilus) hexagonolepis* McClell.
5. *Barbus megalepis.*		*Barbus (Tor) mosal* (Ham.).

I have not examined any examples of the specimen known as *Lobura* to the Assamese, but it may be noted that McClelland himself regarded his *Barbus hexastichus* as a synonym of Hamilton's *Cyprinus tor.* Similarly he considered his *B. megalepis* identical with Hamilton's *C. mosal.* Of the other three species, I have examined specimens of *Burapetea* and *Bokar;* the former is undoubtedly the same as *Cyprinus putitora* Hamilton—the species with the large head. The *Bokar* belongs to a totally different group of *Barbus* known as *Lissochilus,* which has not yet been recorded from the Western Himalayas; its range extends over Indo-China, Siam, Malay Peninsula and Archipelago, Burma and the Brahmaputra Drainage System. The first three species have been dealt with in the earlier articles of this subseries, while the *Bokar* Mahseer forms the subject matter of the present article. It is hoped that some specimens of *Jungha* from Assam will reach the author's hands by February, 1941, so as to enable him to deal with this species in a subsequent article.

History and Nomenclature.

The *Bokar* of the Assamese was described by McClelland as *Barbus hexagonolepis* and characterised as follows:—

'Length of the head to that of the body is as one to four; twenty-seven scales along the lateral line, and seven in an oblique line from the base of the ventrals to the ridge of the back. On the anterior part of the body the exposed surfaces of the scales represent hexagonal outlines, the fins are placed as in the preceding species, but the rays of the ventrals as well as those of the pectorals are small. The fin rays are,

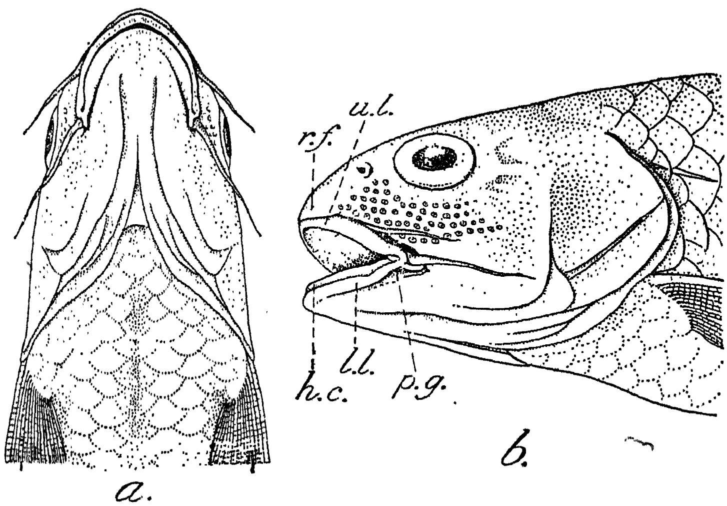
D.12: P.16: V.9: A.7: C.10/9.

'The head is small and little compressed, the snout smooth and slightly rounded, and the postorbitan plates less expanded in this than in any of the other species, having a smooth dorsal spine and large scales. In large-sized individuals the back and head, base of the fins and scales are blackish grey; but the opercular plates, scales, and fins are tipt with yellow. In young ones a leaden hue supplies the place of yellow, and the fins are tipt with black.'

Günther (**2**, p. 129) considered *B. hexagonolepis* as a synonym of *B. hexastichus*, but his description of the latter shows that he was dealing with a species of the *Tor*-type and not of the *Lissochilus*-type. Day (**1**, p. 564) recognised *B. hexagonolepis* as a valid

species and stated that 'The character of the interrupted groove behind the lower lip at once distinguishes this species from *B. hexastichus.*' He gave as its habitat 'Assam in the large rivers, and those from the Himalayas.' All the specimens referred to *B. hexagonolepis* by Day and now preserved in the collection of the Indian Museum possess pores on the cheeks though in most of the specimens the wart-like tubercles have fallen off. However, this tuberculated condition of the snout impressed Day to such an extent that he separated a few young specimens from the Tista river below Darjeeling into a separate species—*Barbus dukai*. I have examined large series of specimens from Assam and the Darjeeling Himalayas, and have not been able to separate them specifically. *B. dukai*, however, has been recorded from Siam (**6**, p. 155) and the Indo-Australian Archipelago (**12**, p. 168). Several species have since been described in the genus *Lissochilus*, but their systematic position is somewhat doubtful, and will form the subject matter of the next article when I hope to deal with the specimens of *Lissochilus* from Burma and the neighbouring areas.

In their treatment of the fishes of the Indo-Australian Archipelago, Weber and de Beaufort (**12**) recognised several genera



Text-fig. 1.—*Barbus* (*Lissochilus*) *hexagonolepis* McClelland.

a. Ventral surface of head and anterior part of body of a specimen from the Tista River, showing the interrupted post labial groove and the structure of the lower lip. *Nat. size.*

b. Ventro-lateral view of same, showing horny tubercles and the structures associated with the mouth. *Nat. size.*

h.c. Horny covering of lower jaw; *l.l.* Lower lip; *p.g.* Post labial groove; *r.f.* Rostral fold; *u.l.* Upper lip.

among the fishes hitherto grouped under *Barbus* Cuvier and proposed the genus *Lissochilus* for *B. dukai* and a new species from Sumatra. The most salient features of this genus, which distinguish it from the true Mahseers of the *Tor*-type, are :—(i) The post labial groove, though continuous round the corners of the mouth, is interrupted

in the middle (*versus* continuous); (ii) the lower lip is conspicuously separate from the jaw, which is provided with a horny covering (*versus* lower lip covering the jaw, which is devoid of a horny covering); and (iii) the snout is provided with horny tubercles or series of open pores (*versus* smooth snout). The horny covering of the lower jaw sometimes becomes inconspicuous in specimens preserved in formalin. In all other respects, these fishes are similar to those assigned to the subgenus *Tor*. For reasons detailed in an earlier article (**9**, p. 276) I think it will be useful to regard *Lissochilus* as a subgenus of *Barbus* till such time as this assemblage of forms is thoroughly monographed and the taxonomic limits of the various genera properly defined.

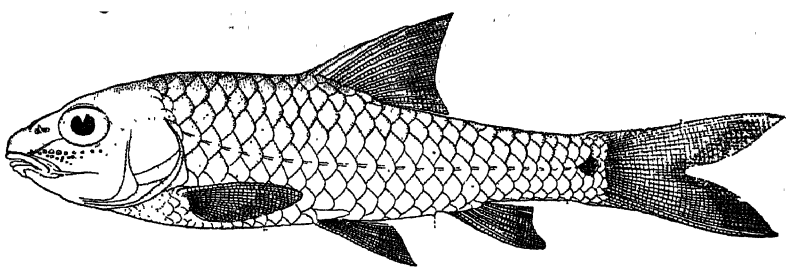
SYNONYMY[1] AND DESCRIPTION.

1839. *Barbus hexagonolepis*, McClelland, *As. Res.*, XIX, pp. 270, 336, pl. xli, fig. 3.
1878. *Barbus hexagonolepis*, Day, *Fish. India*, p. 564, pl. cxxxvii, fig. 4 (pores on snout not shown, present in the specimens).
1878. *Barbus dukai*, Day, *Fish. India*, p. 564, pl. cxliii, fig. 3.
1889. *Barbus hexagonolepis*, Day, *Faun. Brit. Ind. Fish.*, I, p. 305.
1889. *Barbus dukai*, Day, *Faun. Brit. Ind. Fish.*, I, p. 306.
1913. *Barbus hexagonolepis*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 249.
1913. *Barbus hexastichus*, Chaudhuri (*nec* McClelland), *Rec. Ind. Mus.*, VIII, p. 249.
1921. *Barbus hexastichus*, Hora (*nec* McClelland), *Rec. Ind. Mus.*, XXII, p. 186.
1924. *Barbus hexastichus*, Hora (*nec* McClelland), *Rec. Ind. Mus.*, XXVI, p. 27.
1935. *Barbus hexagonolepis*, Hora & Mukerij, *Rec. Ind. Mus.*, XXXVII, p. 389.
1936. *Barbus hexagonolepis*, Hora, *Rec. Ind. Mus.*, XXXVIII, p. 330.
1937. *Barbus hexagonolepis*, Hora, *Rec. Ind. Mus.*, XXXIX, p. 334.
1937. *Barbus* (*Lissocheilus*) *dukai*, Shaw & Shebbeare, *Journ. Roy. Asiat. Soc. Bengal. Science*, III, p. 37, pl. v, fig. 6, text-fig. 33.

Vernacular Names.—*Bhorkol* and *Buluk* (Bengali), *Katli* (Nepali), *Mirpunia* (Lepcha), *Kantasi* (Mechi), *Boka* or *Bokar* and *Boolooah* (Assamese).

D.4/9; P.1/13-15; V.1/8; A.3/5; C.19; L.1.22-31.

In general facies, *Barbus* (*Lissochilus*) *hexagonolepis* is similar to *B.* (*Tor*) *mosal* and has a graceful form in which both the dorsal



Text-fig. 2.—A juvenile specimen of *Barbus* (*Lissochilus*) *hexagonolepis* McClelland from the Kalimpong Duars, showing relatively larger head and eyes, and the development of horny tubercles at this young stage. ×2.

[1] In the synonymy I have included Indian references only. References to extra-Indian records will be dealt with in the next article.

and ventral profiles are more or less equally arched. The head is relatively shorter and broadly rounded in front. The length of the head is contained from 4.5 to 5.6 times in the total length and from 3.5 to 4.3 times in the length without the caudal. The height of the head at the occiput is considerably greater than its width. The most conspicuous feature of the head is the possession of several rows of horny tubercles on the sides in front of and below the eyes. These tubercles are present in smaller numbers in specimens even below 50 mm. in length. The number and arrangement of tubercles vary in different individuals, and when the tubercles are rubbed off or fall away series of open pores are present instead. The eyes are lateral in position and are of moderate size; they are relatively larger in young specimens and are situated mainly in the anterior half of the head; the diameter of the eye is contained from 2.6 to 4.2 times in the length of the head, and according to the size of the specimen it may be greater or smaller than the length of the snout or the interorbital width. The snout is, however, shorter than the interorbital width. The mouth is of moderate size, horizontal and subterminal; it is slightly overhung by the snout. The lips are thick, continuous round the angles of the mouth, but the labial groove is widely interrupted in the middle. The posterior lip is not produced into a flap in the middle. The lower jaw is covered by a sharp, horny covering which enables the fish to rasp off encrusting organic matter from rocks. The barbels are longer than the diameter of the eye.

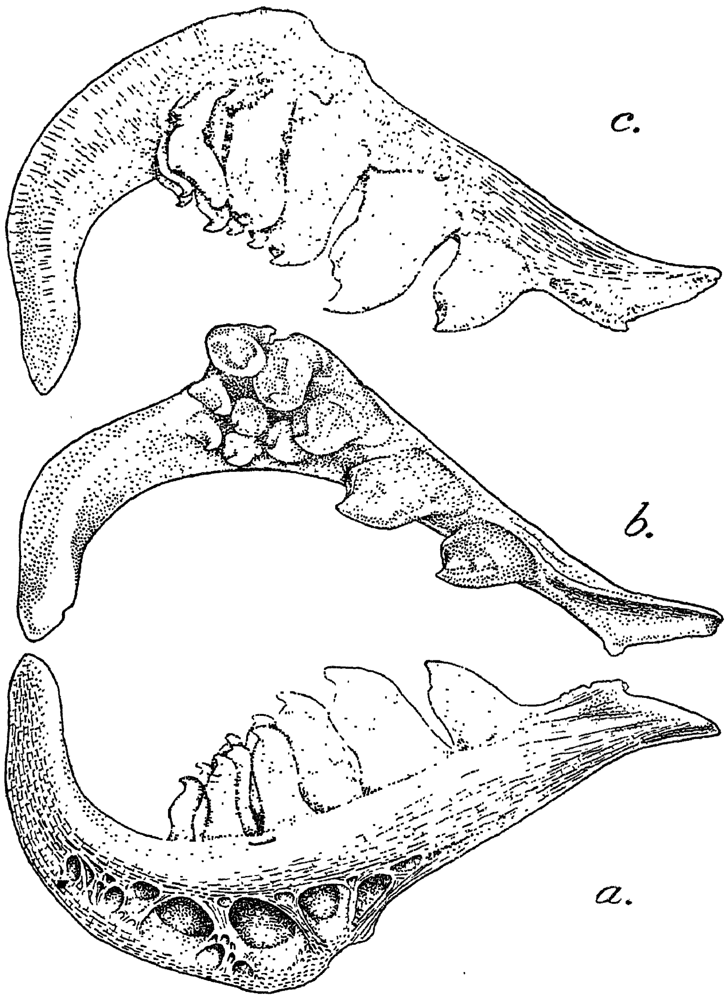
The pharyngeal teeth (5. 3. 2/2. 3. 5) are relatively shorter but more massive than those of the *Tor*-type.

With the exception of a few specimens from Pegu, I have found that the depth of the body is somewhat greater or less than the length of the head; the depth of the body is contained from 4.0 to 5.3 times in the total length and from 3.0 to 4.6 times in the length without the caudal. The caudal peduncle is well formed but narrow; its least height is contained from 1.2 to 1.7 times in its length. The scales are large and well-set; the lepidosis varies considerably even in specimens from the same locality. The number of scales along the lateral line may vary from 22 to 31, of predorsal scales from 8 to 11, and of the transverse series between the lateral line and the base of the ventral fin from 2½ to 3½. An examination of a large series of specimens from different localities shows that no reliance can be placed on this character for separating species. There is a scaly appendage in the axil of each pelvic fin.

The dorsal fin commences opposite to or slightly in advance of the pelvics; its commencement in half-grown specimens is generally slightly nearer to the tip of the snout than to the base of the caudal fin. The position of the dorsal varies with the size of the individuals.

The size and strength of the dorsal spine is also very variable and it has been found that specimens from streams running through lime rocks have better developed spines. The pectoral fin is low and pointed; in young specimens it may extend to the pelvic fin,

but in somewhat grown up individuals the two fins are separated by a considerable distance. The pelvic fins are also sharp and do not extend to the anal fin which latter may or may not reach



Text-fig. 3.—Right pharyngeal bone and teeth of a specimen of *Barbus* (*Lissochilus*) *hexagonolepis* McClelland from below Darjeeling. ×4.

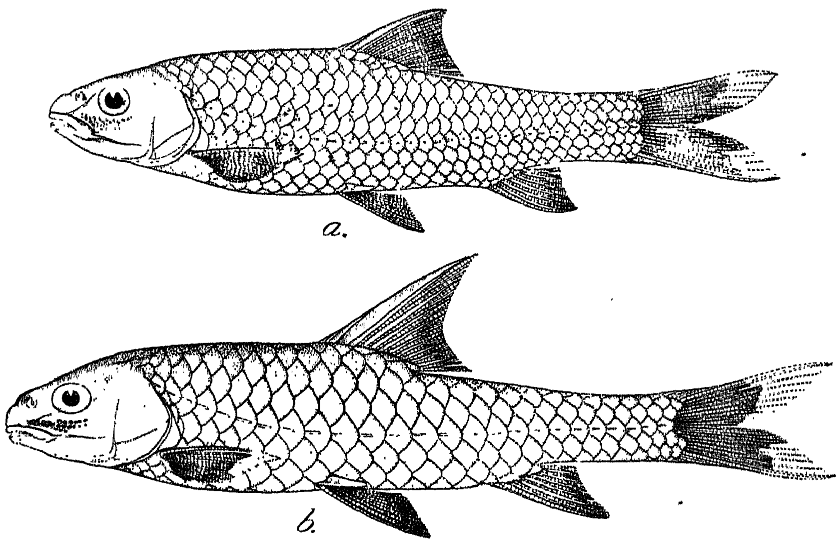
a. Dorso-lateral view, showing the pitted surface; *b*. Lateral view, showing arrangement of teeth in three rows; *c*. Ventro-lateral view.

The teeth are shorter and more massive than those of the Mahseers of the *Tor*-type.

the base of the caudal fin. The caudal fin is deeply forked with both the lobes pointed.

From the observations so far recorded, it seems that the colouration varies considerably according to the nature of the

water inhabited by the fish. The colour sketch reproduced here was made from a living specimen kept in a katchha tank at the Rungli Rungliot Tea Estate, Darjeeling District. The dorsal surface of the head and body was bottle green, the lateral band above the lateral line was yellowish brown followed by an area of king's blue colour which was replaced below by silvery white. The edges of the scales were marked with light bluish neutral tint. The tip of the snout was stone green, and the barbels had a neutral tint. There were two oval patches of a light yellow colour before and behind the eyes; the iris was yellowish brown and the gill-cover light alizarine pink. The dorsal fin had a citron green



Text-fig. 4.—Lateral view of two specimens of *Barbus* (*Lissochilus*) *hexagonolepis* McClelland to show marked variations in lepidosis and nature of dorsal spine. *ca* ½.

a. A specimen from the Naga Hills, Assam, with weak dorsal spine, 32 scales along lateral line and 3½ rows between it and base of the ventral fin; *b.* A specimen from Nepal, with strong dorsal spine. 25 scales along lateral line and 2½ rows between it and base of ventral fin.

colour, while the pelvic, anal and greater part of the pectoral and caudal fins were of a slate gray colour. There was a patch of buff colour on the pectoral and the margin of the caudal was of a light greenish neutral tint.

According to Shaw and Shebbeare (**11**, p. 38), the colour is 'Olive green on back; each scale above the lateral line copper-coloured at the end deepening to bronze-green at the base. Below the lateral line the scales are pale slate-coloured fading to pure white on the belly. Fins deep slate-colour paling towards their margins. Iris bright coppery red.'

MEASUREMENTS IN MILLIMETRES

	Eastern Himalayas, Duars and Terai							Nepal	Assam															
									Garro Hills					Naga Hills									Suddya	Lokra
Total length ...	268·0	...	207·0	...	...	80·0	50·0	215·0	253·0	144·0	137·0	100·0	73·0	298·0	277·0	190·5	185·5	...	158·5	153·0	...	...	...	140·5
Standard length ...	208·0	194·0	146·0	100·0	90·5	59·0	39·0	166·0	202·3	108·5	100·5	77·5	55·5	230·0	210·0	150·0	141·0	127·0	126·0	118·0	106·0	102·0	179·0	105·5
Length of head ..	48·0	48·0	36·7	26·5	24·0	16·5	11·0	42·0	50·0	28·5	26·5	21·0	14·5	59·5	57·0	38·0	39·0	35·0	34·5	32·0	29·0	29·0	44·0	29·0
Height of head ...	37·5	40·0	28·0	20·0	18·0	13·0	8·5	30·0	34·5	22·0	20·0	16·0	10·0	41·5	41·0	27·5	29·5	24·0	23·0	22·0	21·5	19·0	31·3	21·5
Width of head ...	30·0	32·5	23·0	15·0	13·0	11·0	6·0	25·0	28·5	18·5	17·0	12·5	9·0	34·0	36·5	23·5	23·5	20·5	20·0	18·5	18·0	15·0	25·0	18·0
Diameter of eye ...	13·6	13·5	11·0	8·5	8·0	6·2	4·0	13·0	13·5	8·5	8·4	6·9	5·0	15·0	15·0	11·0	11·0	10·5	10·5	10·0	8·5	8·2	12·0	8·5
Length of snout ...	12·3	13·0	12·0	8·5	7·0	5·0	3·0	12·0	16·4	8·3	8·0	6·9	4·0	19·0	20·0	11·0	12·0	11·5	10·3	9·0	9·0	8·8	14·0	8·5
Interorbital distance.	18·5	17·0	13·9	9·5	7·5	5·0	3·0	16·0	17·0	8·5	9·0	6·5	4·5	24·0	21·0	14·0	14·0	11·5	11·0	10·0	10·0	8·8	15·5	10·3
Depth of body ...	55·0	51·0	44·0	28·0	28·3	15·0	9·5	42·0	50·0	30·5	30·0	21·7	15·5	69·0	55·0	41·0	39·0	35·0	34·5	32·0	27·0	26·0	38·5	33·0
Width of body ...	32·5	28·7	25·0	14·0	13·0	9·0	5·0	22·0	26·3	16·5	16·0	12·3	9·0	35·5	35·0	21·5	22·0	18·0	18·3	17·0	16·0	14·5	21·0	17·0
Length of caudal peduncle ...	33·5	35·0	25·5	14·5	14·5	9·2	7·0	26·0	32·5	19·5	18·0	14·0	9·3	39·0	34·0	27·0	25·5	24·0	22·0	21·0	17·0	16·5	32·5	16·5
Least height of caudal peduncle ...	24·5	23·5	18·5	10·5	10·5	7·5	4·9	18·0	22·5	13·0	12·7	10·0	6·5	26·0	24·0	18·0	16·5	14·5	14·0	13·0	11·0	12·5	20·0	13·0
Length of dorsal fin.	40·5	41·8	35·5	D.	22·0	15·0	10·0	47·0	38·5	27·5	24·0	21·0	13·0	50·5	42·0	32·5	28·0	28·5	26·5	25·5	22·0	22·3	37·0	26·0
Length of pectoral fin ...	46·0	39·3	31·5	20·5	20·0	13·6	7·5	D.	43·0	25·0	21·0	17·3	11·0	50·0	50·0	31·5	32·0	27·5	27·5	27·5	23·5	21·0	35·0	23·0
Length of pelvic fin.	39·0	24·0	26·6	19·5	16·0	12·5	6·5	31·5	37·5	20·5	18·5	14·0	9·0	40·5	35·0	25·2	27·0	22·5	20·5	19·0	18·5	18·0	28·5	18·5
Length of anal fin. ...	47·0	34·0	27·0	17·5	14·0	12·0	6·5	35·0	38·0	23·0	20·0	13·0	9·5	38·0	40·5	25·0	30·0	24·0	23·0	18·5	18·0	18·0	32·5	21·5
Length of rostral barbel ...	14·5	13·5	11·9	7·0	5·5	5·3	2·5	12·0	17·0	10·0	9·0	7·8	4·5	12·0	13·5	11·0	12·5	11·5	10·5	10·0	8·0	7·0	12·0	10·5
Length of maxillary barbel ..	17·5	18·0	13·0	9·0	7·0	7·5	2·9	13·0	18·0	10·5	10·0	7·0	4·3	14·0	15·0	13·0	14·0	13·0	11·5	12·0	10·5	8·0	12·0	12·0
Number of predorsal scales ..	1 0	10	9	9	9	8	9	8	9	9	10	10	10	11	10	11	10	10	10	10	8	10	11	9
Number of scales along lateral line.	27	27	25	27	25	25	26	25	27	27	27–28	28	28	30	30	32	30	30	30	28	25	27	31	26
Number of scales between lateral line and v. ...	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	3½	3	3½	3	3	3	3	2	2½	3	2½

Distribution and Size.

Though the final distribution of the species will be discussed in the next article after an account of the extra-Indian material, it may be noted that *B. hexagonolepis* is perhaps the commonest large-scaled Barbel of Assam and of the Eastern Himalayas. In the collection of the Indian Museum there are numerous specimens from the Eastern Himalayas, the Garo Hills, the Khasi Hills, the Naga Hills, and several other places in Assam. There is also a specimen from Nepal. The species has not hitherto been recorded from the Ganges River System or any other part of India.

Both McClelland and Day have noted that this species grows to upwards of two feet in length. Shaw and Shebbeare state that 'Rarely, if ever, exceeding 10 lb. in our area, but W. Nelson records a *Katli* of 25 lb. caught by him in the Champamoli near Gorubasha (Assam).'

In a recent note Holt (4, p. 154) recorded the capture of a *Katli* weighing 21 lbs. from Jaldacca, so it would appear that in Duars also the fish grows to a fairly big size. Mr. S. J. Duncan informed me (*vide* 8, p. 334) that this was the mighty Mahseer of the region traversed by him and that it was found in almost all the rivers of the hills.

Bionomics and Fishing Notes.

McClelland (**10**, pp. 336, 337) made the following observations regarding the bionomics of *B. hexagonolepis*:—

'The stomach is about the length of the body, gradually contracting till it joins the intestines, which are thrice the length of the stomach, but of great capacity, expanding in size from their commencement, to about the middle of their length, and again gradually contracting until they reach the vent. In the stomach and intestines I found numerous minute bones of small fishes. Instead of the intestines of this species being disposed in transverse or longitudinal folds, they are convoluted transversely. Mr. Griffith remarks that the *Bokar* is to be found in all large rivers on the eastern frontier, from the base of the mountains to the situation at which the currents first become languid in the plains, keeping mostly in the middle of the stream, where it takes a red hackle very freely, as well as worms and other bait. It is very powerful, often attaining two feet and upwards in length, and usually weighing from eight to twelve pounds.'

Wood (**13**, pp. 71, 72) in his notes on *Fishing in India and Europe* recorded the following observations regarding *Booka* or the snub-nosed Mahseer :—

'The *Booka* or snub-nosed Mahseer. This is a true Carp and the colour is duller than in the last; the fins are bluish-red and the pharyngeal teeth are broader and flatter. As the *Booka* is not such a cannibal as the true Mahseer, feeding more on falling fruits, weeds, grasses, etc., it does not attain to a very great size, 12½ lbs. being the heaviest I ever got. A curious thing about him is that his fins are never entire, pieces especially in the caudal fin being bitten out. The Khasias have told me that this is done by a little fish with a beak like a parrot and which can blow itself out. They call it the *Poothla Mas*. I have seen little boys blowing these fish up as one does a toy balloon. Sometimes when bathing these fish will nip your legs. The Khasias hate the *Booka* and many will not eat them, as they say they devour the excrement of monkeys. I fancy there is something in this. A fruit which they are fond of, a species of small fig is often found on

trees overhanging the water. I have seen hosts of monkeys feeding on the berries and when the fruit[1] fell into the pool below it was eaten by the *Booka* and other fish; the excrement also dropped into the water and I do not think the *Booka* would object to eating this. The *Booka* does not make the terrific rush like the Mahseer, he rather bores down into the depths of the water and shakes the line like a bull dog. By this feeling you can always tell you have a *Booka* on. They take a G and S spoon well but one has to spin deep for them and in a pool they soon get scared of a spoon. During a sudden heavy spate, when the river gets muddy like pea soup, I have seen *Booka* spring into the air to get more oxygen. The teeth of the true Mahseer are much longer and pointed than those of the *Booka*, some having a distinct notch. They play on a hinge system and the teeth point downwards into the pharynx. They are admirably adapted for cutting purposes and their strength can be gauged by putting one's fingers down the throat of a small Mahseer.'

Shaw and Shebbeare (**11**, p. 38) noted that the habits of *Katli* are 'Very similar to those of the Mahseer. As a sporting fish there is nothing to choose between them, weight for weight. It is unfortunate that, as both take the same lures, and are found in the same water, the smaller species is often taken on much too heavy tackle which does not give him a chance to show his power.'

ACKNOWLEDGMENTS.

I am indebted to the authorities of the Bombay Natural History Society for bearing the cost of the illustrations for this article. Mr. K. S. Misra very kindly prepared the table of measurements and for this my thanks are due to him. The colour sketch was made from a specimen caught by Mr. W. K. Langdale Smith of the Rungli Rungliot Tea Estate, Darjeeling District, from the Tista River and later kept by him in a Katchha tank. I am indebted to Mr. Langdale Smith for affording facilities to my artist to make the colour sketch. The illustrations were prepared by Babu B. Bagchi with his usual skill and care under my supervision.

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[1] In this connection reference may be made to Hopwood's (**5**) observations on 'Effect on Mahseer of eating the fruit of the Kalaw tree (*Taraktogenos Kurzii*)'. The flesh of the fish which eat the fruits of this tree becomes poisonous.

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EXPLANATION OF PLATE.

Colour sketch of a tame Katli, *Barbus* (*Lissochilus*) *hexagonolepis* McClelland of the Tista River.

The specimen, 268 mm. in total length, was collected by Mr. W. K. Langdale Smith, and kept in a katchha tank at the Rungli Rungliot Tea Estate, Darjeeling District. The colours shown in the drawing probably differ from those of specimens living under natural conditions.

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[*From the* JOURNAL OF THE BOMBAY NATURAL HIST. SOC., *December* 1939.]

THE GAME FISHES OF INDIA.[1]

BY

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(*With one coloured plate, one black and white plate and two text-figures*).

(*Continued from page* 71 *of Vol.* xli).

VIII.—THE MAHSEERS OR THE LARGE-SCALED BARBELS OF INDIA.

1. THE PUTITOR MAHSEER, *Barbus* (*Tor*) *putitora* (Hamilton).

CONTENTS.

INTRODUCTION.

In my prefatory note (7)[2] to the present series of articles on 'The Game Fishes of India' it was stated that the taxonomy of Indian fishes, especially of the freshwater species, was in a state of great confusion, and attention was directed to the fact that even in the case of the most valuable game-fish Mahseer the precise generic and specific limits of the forms included under this composite term were not easy to elucidate. The preceding seven articles have made it abundantly clear what an amount of spade work is needed to assign proper scientific names to our commonest food fishes. In dealing with the Mahseers this difficulty is greatly accentuated, because characters, such as scale-counts, fin-rays, colouration, etc., usually employed in distinguishing various species of the Carp tribe have proved of little use in separating the large-scaled Barbels of India into species, subspecies or varieties. The

[1] Published with permission of Director, Zoological Survey of India.
[2] Numerals in thick type within brackets refer to the serial numbers of the various publications listed in the bibliography at the end of the paper.

following observations of Thomas (**13**, pp. 27, 28) regarding the varieties of Mahseer are of special interest in this connection:

'Further experience has confirmed me in the view advanced in 1873, that there are more Mahseers than have been named, and that if it were possible that as much accurate attention could be given to the Mahseer as has been devoted to the Salmonidae of Great Britain, of Europe, and of America, it would be found that the Mahseers of India would likewise grow in numbers. No one who has not tried it can form any idea of the amount of labour required to collect specimens sufficient to clear up a moot point, to decide which differences are only accidents of local colouring, which the ordinary result of the change of season, which indicate only varieties, and which serve to constitute separate species. To satisfy an accurate mind specimens must be collected from many rivers, in many localities, at various ages, in various seasons, and in goodly numbers; and all details of capture must be reliably noted at the time; all these facts which form the basis of conclusions should also be retained for the satisfaction of other enquirers.'

After making fairly extensive collections, Thomas advanced the view 'that there are at least three distinct forms with difference of external structure, and many more with differences in colouring'. Not being an angler, I am in a less fortunate position to make field observations on Mahseers, but from the preserved material and literature at my disposal at the Indian Museum I shall attempt to define in a chronological order the precise specific limits of the various types of Mahseers described from different parts of India and Burma. At present it is not possible to determine the relations of one with the other; but this will be taken up after the treatment of the various varieties is completed. It will also not be possible to give in the first instance an accurate account of the geographical distribution of each species. The readers are requested to send material of and observations on the bionomics of Mahseers to the Bombay Natural History Society so that in course of time the information can be codified and presented in a suitable form to the angling world.

So much has been written on the methods of fishing for Mahseer that it seems hardly necessary for me to discuss the matter in this series, but in the last article on the Mahseers of India a resumé of what is known along with a general account of the bionomics of these fishes will be given.

Etymology of Mahseer and List of Vernacular Names.

Thomas (**13**, p. 34) noted that

'The name Mahseer is perhaps derived from the Hindustani words *maha* great and *sir* (pronounced *seer*) head, or perhaps, as a friend writes me from Delhi, on the authority of a native gentleman there who has been a great angler and is a well-known Persian scholar, from the two Persian words *mahi* a fish and *sher* a lion, in recognition of its gameness.'

According to Dhu (**4**, p. 5), Mahseer is derived from *Matsya*, 'the Sanskrit word for fish used in the Vedas, and as the Mahseer is undoubtedly the sacred fish of India, it is more than likely that Mahseer is simply a corruption of Matsya. Maha Sir big head,

is an alternative derivation.' Lacy and Cretin (**11**, p. 2) discuss the etymology of Mahseer in greater detail and remark

'The derivation of Mahseer from maha sir—big head—may be merely an attempt to give a meaning to the word. The derivation from maha sher—big tiger—is fanciful, although the natives sometimes pronounce the word Mahsher; it is merely the soft equivalent of the word. A third and a good derivation is from Mahasaula, Mahasalka—big scaled. The natives often call the fish Mahsol. The Mahseer has got bigger scales than any other fresh-water fish in India. Its big scales form one of its best distinctive characters. A big Mahseer has got scales as big a the palm of one's hand which make the use of the gaff unsafe. The scales are used as playing cards in some parts of India. A fourth, and a likely, derivation is from *Matsya*, which is the Sanskrit word for 'fish', and is used in the Vedas. As the Mahseer is a sacred fish, preserved near many Hindu temples, it is probable that the Brahmans called it 'Fish' par excellence, pronouncing the word Mahsia.'

In the Dak Edition of the *Statesman* of Calcutta, dated the 27th June, 1939, KIM on the authority of Mr. Mohsin Hosain Rizwi contributed a note on the etymology of Mahseer. It is stated therein that the word Mahseer has no phonetic or etymological resemblance to the Sanskrit word 'matsya', and as Mahseer is not a particularly bigheaded fish, therefore, the name cannot be derived from 'maha sir'—big head. The derivation which strikes Mr. Rizwi as more probable, simpler and more logical is that the word 'mahseer' is the corruption of the Persian word 'Mahisher' —*mahi* meaning fish and *sher* a tiger, the reference being made to the tigerish and sporting character of this great game fish.

KIM in agreeing with Mr. Rizwi's observations remarked that in his opinion the 'sir' of Mahseer had nothing to do with the head. 'The "sir" referring to the head is pronounced quite differently from the second syllable of mahseer. The "sir" meaning the head is pronounced like the sir in sirrah, whereas the second syllable of the word for fish is pronounced as it is spelt, "seer", like the word for a sage or prophet.'

Finding so much confusion about the etymology of Mahseer I referred KIM's observations to my cousin, Dr. B. Ch. Chhabra, Assistant Superintendent for Epigraphy in India, and he very kindly sent me the following opinion:—

'As regards the discussion about the name *Mahseer*, let me at once say that Mr. Rizwi's Persian derivation of it from *mahisher* is fanciful and far fetched. In the first instance the compound ought to have been *shermahi* in the sense he takes it. Moreover, Kim's objection applies to this *sher* as well as it does to *sir*. Let me in passing also point out that the so-called Persian word *mahi* for fish is a corrupt form of the Sanskrit *matsyī* 'female fish' though it looks so strange.'

Dr. Chhabra then gives details of the process by which the Persian *mahi* is derived from the Sanskrit *matsyī*, giving numerous instances in support of his arguments. He thinks that the term Mahseer 'is derived from *mahāśiras*, the reference to greatness or bigness may be to the front part of the fish and not only to its head or snout'. This derivation is supported by Yule and Crooke (**15**, p. 538) in *Hobson Jobson*. To meet KIM's objection that the vowel in *seer* of Mahseer is not like in 'sirrah' but is like that in 'seer', Dr. Chhabra suggests the derivation to be from *mahāśīrsha*

without altering the sense. The dropping of the final *sha* in a corrupt word is not impossible, *śiras* or *śīrsha* mean the same thing.

I have also consulted Mr. T. N. Ramachandran, Superintendent, Archaeological Section, Indian Museum, and he agrees that Mahseer is very likely a colloquial form of *Mahāśīrsha* or *Mahāśiras.*[1]

There are several local names under which Mahseers are known in different parts of India. In recording *Cyprinus putitora* from the Rangpur District, Hamilton (*vide* Day **3**, p. 50) noted that

> 'The *Mahāsaul* of the polished dialect of Bengal, called Putitor in the vulgar dialect of Goalpara, is the largest of the carp kind that we have, and is often found nine feet in length, and six feet is an usual size. The scales are exceedingly large, being like the hand, and at Dacca are often made into cards with which people game. It is reckoned coarse food.'

There is hardly any doubt that in *Mahāsaul* reference is made to the large scales of the fish and that the term is derived from the Sanskrit *mahāśalkalin*, meaning a fish with large scales.

The following are some of the vernacular names under which Mahseers are known in different parts of India and Ceylon :—

Putitor (Goalpara); *Tor* (Rangpur); *Sŭhărá* and *Tŭrĭyá* (Purneah); *Mŭsăl* (Kosi R.); *Kajrá* (Dáŭdnagar, Sone R.); *Burapatra, Junga Peetia* (Assam); *Naharm* (Hindi); *Kukhiah* (Punjab); *Kurreah* (Sind); *Kendi, Bŏm-mín* (Tamil); *Peruval, Harale-mìnu* (Canarese); *Hŭllămìnu* (Mysore Canarese); *Meruval* (Malayalam); *Heragălu, Peruval* (Tulu); *Kadchi, Masta* (Marathi); *Kuriah, Lela* (Ceylonese).

NOMENCLATURE.

Hamilton (**6**, pp. 303-307) included 3 varieties of Mahseer, *viz.*, *Cyprinus putitora, C. tor* and *C. mosal*, in his fourth heterogenous division of the genus *Cyprinus* which he termed *Cyprinus* proper. He observed that the fishes of this division are of large size and thick form, and are provided with a short anal fin. The genus *Cyprinus* Artedi is, however, restricted to the true Carp found in the temperate parts of Europe and Asia; it is not found in India proper, but a subspecies was described by Annandale (**1**, p. 47) from the Southern Shan States, Burma. Of the 15 species included under the division *Cyprinus* proper Hamilton recognised the close affinities of the 3 varieties of Mahseer for he (**6**, p. 303) observed under *C. putitora* that

> 'This and the two following species have, in many points, a strong resemblance, being very large fishes, affording an excellent wholesome nourishment, free from bones, although not quite so delicate as the *Rohita*. They are all also strong, well-formed, handsome fishes, peculiarly distinguished by the enormous size of their scales, which, in large individuals, almost equals the hand, insomuch, that cards for gaming are sometimes made of them at Dakha.

[1] In the last article of this series about *Wallagonia attu*, one of the Sanskrit names mentioned for *Mulley* or *Boali* (**8**, p. 66) was *Mahasira*, in which reference is certainly made to the large front part of the fish.

Mahasaula and *Tora*, variously altered or corrupted, or with various additions, may be considered as generic appellations among the natives for these fishes, all of which frequent large rivers.'

Unfortunately Hamilton did not figure any one of the three species in his monumental work on 'Gangetic Fishes', but among his manuscript drawings, now preserved in the Library of the Royal Asiatic Society of Bengal, he left drawings of *C. tor* and *C. mosal*. These were published by Gray (5) without any letterpress or acknowledgment; the latter species appears on plate 93 of Volume I of *Illustrations of Indian Zoology* under the name '*Cyprinus mosal* Hamilt.', while the former is published as '*Tor Hamiltonii*' on plate 96 of Volume II. Though the large-scaled Barbels have been variously referred to the genera *Barbus* Cuvier, *Labeobarbus* Rüppel, *Barbodes* Bleeker, *Tor* Gray, etc., according to the modern usage they are placed generally in the genus *Tor* Gray, with *Cyprinus tor* Hamilton (= *Tor Hamiltonii* Gray) as the genotype. *Barbus*, found in Europe, throughout Asia and Africa, is one of the most extensive genera of freshwater fishes, and several authors have attempted to divide it into genera and subgenera which gradually pass one into another. In the majority of cases these divisions have not been permanently accepted. Unless an attempt is made to monograph the Cyprinidae of the whole word, probably it will not be possible to define the precise generic limits of the various forms and till such time I think it may be useful to treat *Tor* as a subgenus of *Barbus*.

The fishes of the subgenus *Tor* are elongate and moderately compressed. The snout is more or less prominent. The mouth is inferior or subinferior, and horseshoe-shaped; the upper jaw is strongly protractile. The lips are more or less thick and continuous; the labial fold is uninterrupted and generally its median part is developed into a lobe which is very extensive in some individuals; in certain forms the upper lip is also greatly developed. There are two pairs of small, but well defined, barbels, one pair rostral and one pair at the angles of the mouth. The suborbital bones are narrow. The dorsal fin is provided with 8-9 branched rays and commences either before or opposite the origin of the pelvic fins; its last undivided ray is large, osseous and smooth; generally it is very strong but in certain forms it is comparatively feeble. The anal fin is short, with 5 branched rays. The scales are very large, about 23 to 30 in a series along the lateral line which runs to the middle of the base of the caudal fin. The gill-membranes are united to the isthmus. The pharyngeal teeth are spoon-shaped and are arranged in 3 series 5. 3. 2—2. 3. 5.

According to Weber and de Beaufort (14, p. 148), the fishes of the *Labeobarbus*-type are found in 'Fresh water of Indo-Australian Archipelago (Sumatra, Java, Borneo), of Asia and Africa.'

The Mahseers belong to a very large family of Carp, though in their size, flavour, activity, etc., they are quite different from the true Carp of Europe. It is for this reason that they are usually called Barbels. They belong to the order Cyprinoidea of the

Physostomous fishes, to the family Cyprinidae and to the subfamily Cyprininae.

History and Description.

Hamilton (**6**, p. 388) characterized his *Cyprinus pulitora* as follows:—

> 'Cyprinus verus cirrhis 4; radiis in pinna dorsali 11, duobus prioribus simplicibus, in pinna anali 7; squamis maximis; rostro laevis imperforato; labiis integerrimis; pinnis pallidis.'
>
> 'B 3, D 11, P 15, V 9, A 7, C 19+ .'
>
> 'Varietas cirrhis 2; radiis in pinna dorsali 10, in anali 8.'

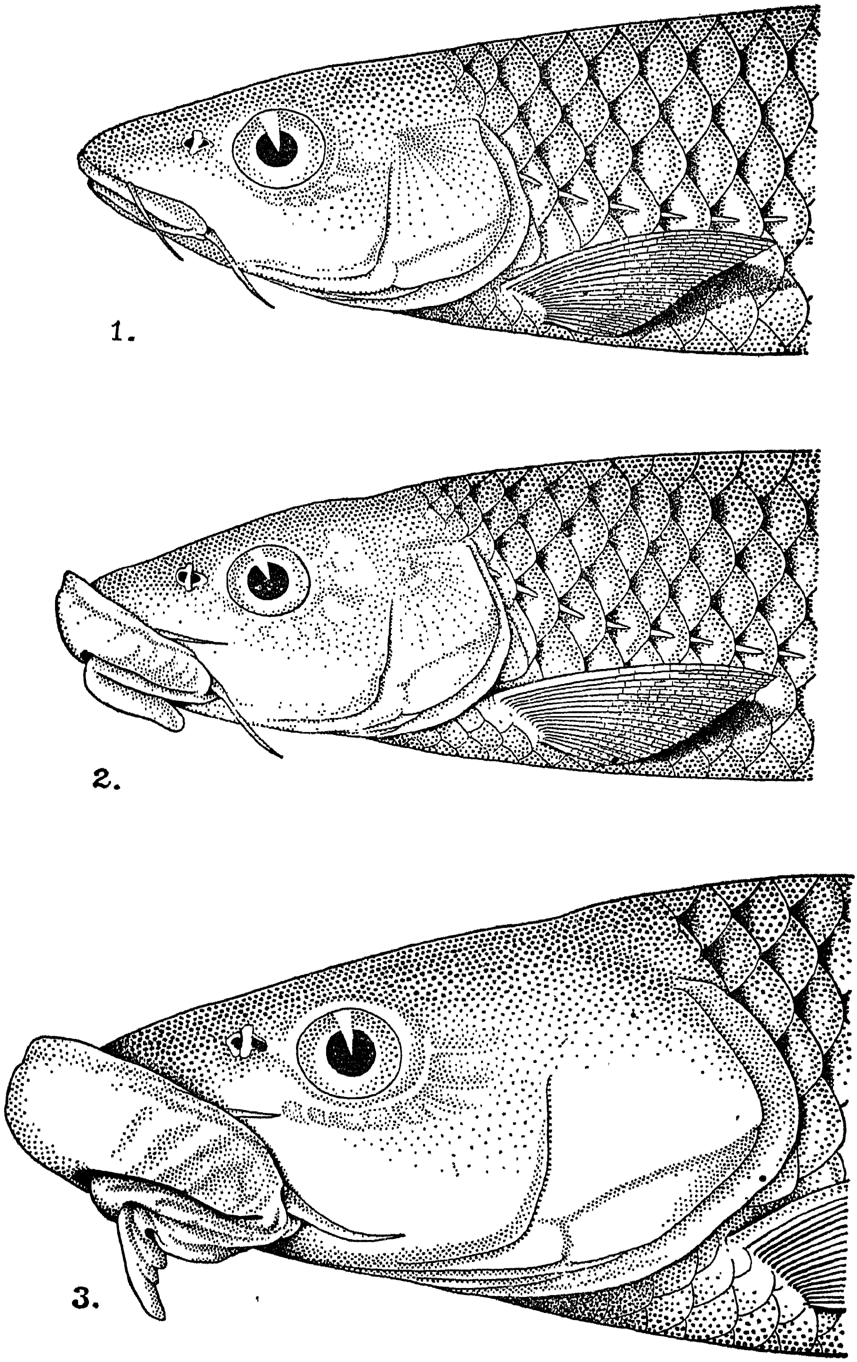
The species was described by Hamilton from 'the eastern parts of Bengal', and was stated by him to grow to 9 feet in length. According to his notes on the fish and fisheries of Bengal (*vide* Day **3**, p. 50) he seems to have observed *C. putitora* only at Goalpara in the district of Rangpur. I have already quoted (p. 275) his brief account of the fish as given in these notes. Unfortunately he made no drawing of the species and his description is so generalised that the later workers found it difficult to recognise it as a valid species. McClelland (**12**, p. 399) is perhaps the only earlier ichthyologist who recorded as *Barbus putitora* a specimen collected at Ningpo in China. Hora and Mukerji (**8**, p. 140), as a result of the collections made by them in the Eastern Doons, discussed the specific limits of the three forms described by Hamilton and came to the conclusion that *B. putitora* is abundantly distinct from *B. tor* but may be conspecific with *C. mosal*. They attached considerable importance to the colour of the fins (yellow in *putitora* versus red in *tor*); to the form of the back in front of the dorsal fin (sharp in *putitora* versus convex in *tor*), and the relative size of head when compared to depth of body (head considerably greater than depth of body in *putitora* versus head considerably shorter than depth of body in *tor*). Further material collected since then has shown that all the three species of Hamilton are probably distinct. I propose to describe here the first species of Mahseers mentioned by Hamilton, e.g. *Barbus* (*Tor*) *putitora* (Hamilton).

Barbus (Tor) putitora (Hamilton).

1822. *Cyprinus* (*Cyprinus*) *putitora*, Hamilton, *Fish. Ganges*, pp. 303, 388.

D. 4/8; A. 2/5; P. 17-18; V. 1/8; C. 19.

The Putitor Mahseer is an oblong, somewhat compressed, streamlined, trout-like fish in which both the profiles are gently and gracefully arched. The head is broadly pointed anteriorly and behind the anal fin the tail becomes considerably narrow. The length of the head is always considerably greater than the depth of the body; it is contained from 3 to 3.6 times in the standard length; the head is relatively longer in younger specimens. The depth of the body is relatively greater in young individuals; it is contained from 1.1 to 1.4 times in the length of the head. The eyes are



The Putitor Mahseer, *Barbus* (*tor*) *putitora* (Hamilton).

(*For explanation see end of article*).

far forward and are provided with circular pupils; they are proportionately larger in the smaller individuals; the diameter of the eye is contained from 2.8 to 5.3 times in the length of the head; from 0.8 to 1.7 times in the length of the snout and from 0.7 to 1.4 times in the interorbital distance. The least height of the caudal peduncle is contained from 1.4 to 1.8 times in its length.

The mouth is small; its gape does not extend to below the eyes; it is horizontal with the opening obliquely directed upwards. The lips are fleshy and continuous at the angles of the mouth; the posterior lip is produced into a median lobe and the post-labial groove is continuous. The condition of the lips varies greatly in individuals of different sizes and in those collected from different localities (for detailed account see pages 279-280). There are two pairs of barbels[1] which are more or less of equal length and are almost as long as the diameter of the eye. The body is covered with large scales; there are 25 to 28 scales in a longitudinal series along the lateral line; 2½ rows between the lateral line and the base of the pelvic fin; 4½ rows between the lateral line and the base of the dorsal fin; 9 scales before the dorsal fin and 12 round the caudal peduncle. There is a well developed scaly appendage in the axil of the pelvic fin.

The commencement of the dorsal fin is opposite to that of the pelvics, and is almost midway between the tip of the snout and the base of the caudal fin. The last spine is very strong and bony; it is generally shorter than the depth of the body below it, but in some individuals it is equal to the body height. In a specimen from Murree, however, it is considerably longer than the depth of the body. The pectoral fins are low, considerably shorter than the head and sharp above. The pelvic fins do not reach the anal opening. The anal fin does not extend to the base of the caudal fin. The caudal fin is sharply divided, with the lower lobe somewhat more pointed.

Hamilton (6, p. 304) noted that the colour is dusky above 'with a gloss of steel, while the edges of the scales changed from gold to silver. The lower parts resemble entirely the latter. The fins are without spots, and the hinder ones are tinged with yellow. The eyes are like silver'.

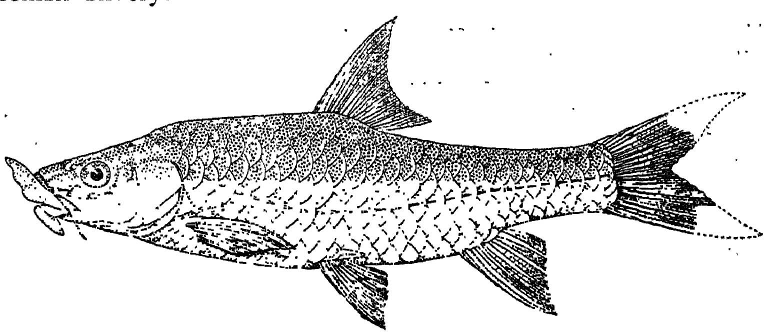
The colours vary considerably according to the nature of the waters inhabited by the fish. In a small, fresh specimen, about 9 inches in length, collected from the Tista river near Washabari Bazaar in the Eastern Duars, the dorsal surface of the head and a small anterior portion of the body were found to be of a Lincoln green colour while the ground colour of the remaining portion of the dorsal surface of the body was warm buff which faded into light pink at the sides and silvery white on the ventral surface. On the sides, between the upper angles of the gill-openings and the base of the caudal fin, there were broad bands of light mineral gray. Each scale was anteriorly marked with a gray blotch. The portion

[1] Hamilton (6, p. 305) records that he examined one specimen in which there were only two barbels. This has to be regarded as a case of abnormality.

of the tail in front of the caudal fin was marked with an irregular, broad, vertical band of amber yellow. The operculum and the sides of the snout were of gray colour while patches of orange and yellow colour were present on other parts of the head. The dorsal fin was light yellow in colour while its rays were conspicuously yellowish gray. The fin was provided with a broad band of mineral gray across the rays. The pectoral fins were pink at their bases and citron yellow distally. The pelvic fins were yellowish with a tinge of pink at their bases and extremities. The anal fin was likewise citron yellow with pink extremity. The caudal fin was also citron yellow with its rays of mineral gray colour; it was edged with pink and gray.

The colour plate reproduced here shows the colouration of a specimen about $3\frac{1}{2}$ feet in length collected by Mr. W. K. Langdale Smith from the Tista river and kept in a kachha tank at the Rungli Rungliot Tea Estate, Darjeeling District. Under these artificial conditions its colouration in life was as follows:—

The back was reddish sap green and along the sides above the lateral line there was a broad band with a purplish shadow throughout. Below the lateral line the body was light orange which faded into silvery white on the belly. The head below the level of the eyes was light buff yellow which was replaced ventrally by a light neutral tint. The iris was light green while the pupil was dark blue. The scales in the upper half of the body were marked anteriorly by reddish sap green colour while in the centre they were brilliantly orange, their posterior edges were of peacock green in colour with shades of light and deep sap green anteriorly. The pectoral, pelvic, anal and caudal fins were peacock green in colour; the distal tip of the anal was marked with a patch of reddish orange, while the posterior border of the caudal fin was marked with reddish green. The tubes on the lateral line were greenish silvery.



Text-fig. 1.—Lateral view of an African species of *Barbus, B. cunningi* Gilchrist, with greatly developed lips. ×3/8.
(After Gilchrist, *Ann. South Afr. Mus.*, xi, p. 392, 1918).

Note on the enlargement of lips (*Plate II*) :—Reference has been made above (*vide* p. 278) to the hypertrophied lips of certain individuals. Such an enlargement of the lips is to be found not

only in several species, races and varieties of the Indian Mahseers, but in the large-scaled Barbels of the neighbouring countries and of Africa as well. Thomas (13, p. 32) discussed the systematic value of this character and observed:

'I have found this peculiar formation occurring in all the places spoken of above, except in Northern India[1], where I have not fished enough. It cannot indicate a mere variety for I have found it so frequently. Does it indicate a species, or is it a temporary growth like the beak of a male salmon in the spawning season? It cannot be the latter, because I do not remember to have ever seen it half developed, and I have notes of having frequently observed it fully developed in small immature Mahseer of 1 lb. in weight and under, down to fry of five, five and a half, and six inches, in length, when they could hardly be breeding.'

Thomas then gives the opinion of the local fishermen who regard the thick-lipped forms as females, but in view of the fact that a 'number of such very small Mahseer being caught with the lips not partially but thoroughly developed, militates against their being females.' His conclusion is that they are distinct species. 'But what the function of these prolonged lips and beard may be I cannot conceive. It is left as a puzzle for my readers to work out.'

Hora and Mukerji (8, p. 140) also noted differences in the structure of the lips of various individuals collected by them in the Eastern Doons and remarked:

'Among the yellow-finned forms there are two types: (i) The lips are fleshy and the lower one is produced backwards into a long fleshy appendage; the snout is blunt; (ii) The lips are of the normal type and the lower lip does not form an appendage; the snout is rather pointed. We believe that these differences are correlated with sex; the former type represents the male and the latter the female.'

The above conclusion was based on an examination of immature specimens, but as these differences are sometimes fairly pronounced even in fry of a few inches in length I agree with Thomas that probably they are not secondary sexual characters.

While re-examining the material from the Eastern Doons I found that all the specimens, 8 in number, collected from the Song River at Lachhiwala possess well-developed lips while 6 specimens obtained from the Suswa River have lips of the ordinary type. From the field notes made at the time of collecting the material and from personal recollections of the nature of the two streams, it can be stated that the Song River is a large torrential stream with rocky and gravelly bed, but without any marked waterfalls. The Suswa River near Sat Narain is a comparatively sluggish stream with sandy or pebbly bed.

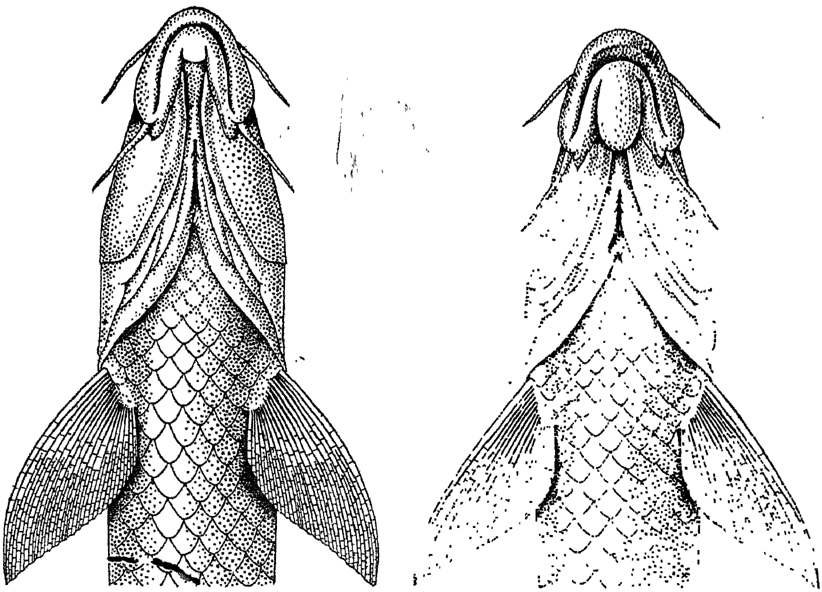
With regard to the enlargement of the lips Day (2, p. 77) noted that

'Amongst 20 specimens all of about 10 inches in length and taken the same day in the *Chukkee*, a hill affluent of the Sutlej, I found in two the snout

[1] Enlargement of lips is equally marked in several types of Himalayan Mahseers as will be evident from this as well as the following articles in this series

elongated overhanging the upper jaw, in several the middle of the upper lip elongated, but to varying lengths, and in a smaller number no elongation of the upper lip. The median lobe of the lower lip was very variously produced, but apparent in all.'

It is clear from the above that Day also found the enlarged lips practically in all the specimens collected from a torrential tributary of the Sutlej River in the Himalayas.



a. *b.*

Text-fig. 2.—Ventral surface of head and anterior part of body of two specimens of about equal size from the Eastern Doons. $\times 1\frac{1}{3}$.

a. A specimen, 141 mm. in total length, from the Suswa River near Sat Narain showing plain lips, and a small median lobe of the posterior lip.

b. A specimen, 140 mm. in total length, from the Song River at Lachhiwala showing hypertrophied lips, and a well-developed, beard-like median lobe of the posterior lip.

As in Carp in general, the jaws of Mahseer are protrusible so that the lips can be applied to the substratum to form a sucker. It is conceivable, therefore, that hypertrophied lips are characteristic of only those individuals which live in shallow torrential streams where they enable the fish to adhere to rocks and stones in the same way as the Lampreys do in rocky streams. The forms with thick lips generally possess a more graceful and stream-lined body which also points to their torrential habitat.

To test the above hypothesis, which for the time being may be regarded merely as a tentative suggestion, Museum collections are not helpful. For example, of 13 specimens, ranging in standard

length from 116 mm. to 243 mm., of the Putitor Mahseer from the Kangra Valley, Punjab, very kindly sent by Dr. Hamid Khan, 6 possess ordinary types of lips, while in the remaining examples the lips are greatly thickened and the median lobe of 4 specimens is co-extensive with the extent of the mouth. As this lot is noted to have been collected 'from Kangra streams', it is now impossible to correlate the differences in the development of lips with differences in their habitats. To elucidate this problem it is highly desirable that anglers may kindly note the condition of the lips of the Mahseers caught by them and also make a detailed note of the length. The sex of the individual must also be noted by a rough examination of the gonads, but if it is difficult to be sure whether it is an ovary or a testis the same may be preserved and sent, with other particulars, to the Bombay Natural History Society for further study. The accumulation of these data will enable us to arrive at a satisfactory conclusion regarding the mystery that surrounds the hypertrophied condition of the lips in certain Mahseers. One thing is, however, clear that it cannot be relied upon as a character for differentiating species.

Bionomics :—As a result of their studies on the material collected from the Eastern Doons, Hora and Mukerji (8, p. 142) made the following observations on the feeding habits and the breeding period of the species:—

> 'In most of the specimens dissected, the stomach was found to be empty showing that the feeding is probably intermittent in this species. The alimentary canal is considerably shorter than that of *B. tor*, being 2.6 times as long as the length of the fish. The fish feeds on green filamentous algae, insect larvae, water plants, slimy matter from rocks, etc. Judged by the length of its intestine, it would appear to be more carnivorous than *B. tor*.
>
> '*B. putitora* is represented by a large number of young specimens in our collection. This species also seems to breed in August-September. The fry is provided with a black spot in front of the base of the caudal fin.'

Hamid Khan (**10**) has studied the sex organs of Mahseer of the Punjab and has come to the conclusion that 'it spawns three times in the year, and that all the eggs in the ovaries are laid at each spawning season'. The three spawning seasons are, (i) January and February, (ii) May and June (snow melts), and (iii) July to September (monsoon months). Unfortunately, Dr. Hamid Khan had no opportunity to examine the actual specimens, so it is difficult to say whether all the samples of gonads studied by him belonged to the same species. However, from the material sent to me from the Kangra Valley, referred to above, it seems probable that *Barbus* (*Tor*) *putitora* is the commonest Mahseer of the Punjab waters.

Geographical Distribution:—*Barbus* (*Tor*) *putitora* is found all along the Himalayas. Measurements of specimens from Kashmir to the Darjeeling Himalayas are included in the table given overleaf. Though it is reported (**12**, p. 399) from China also, in the present confused state of our knowledge it is very difficult to form an exact idea of its range of distribution.

MEASUREMENTS IN MILLIMETRES

	Murree	Kangra			Dehra Dun					Naini Tal & Almorah			Trebeni River, Nepal Terai	Tista River, below Darjeeling		
Total length ...	...†	150·0†	292·0*	308·0†	117·5*	184·0*	184·0†	233·5*	314·0*	...†	78·0†	106·0†	107·0†	140·0†	351·0†	1060·0†[1]
Standard length ...	138·0	117·0	238·0	242·0	90·0	140·0	140·0	180·5	248·0	45·0	60·0	82·0	82·0	103·0	291·5	850·0
Length of head ...	39·0	33·5	66·5	71·5	28·5	43·3	41·3	53·5	73·5	14·0	20·0	25·0	25·0	31·0	85·0	250·0
Width of head ...	19·0	17·0	34·0	34·0	14·0	21·0	21·0	28·5	39·0	7·0	9·5	12·5	11·5	14·0	39·5	107·2
Height of head ...	25·5	20·5	41·5	44·3	18·5	25·8	27·0	32·6	45·0	9·0	13·0	16·5	15·0	17·5	45·5	134·1
Diameter of eye ...	11·0	9·0	14·0	14·5	8·2	11·0	11·0	12·3	15·0	5·0	5·6	7·0	7·5	9·0	16·0	38·1
Length of snout ...	10·0	10·0	23·0	22·0	10·0	14·8	12·5	19·0	25·5	4·0	5·6	7·0	7·2	9·0	26·5	73·3
Interorbital width ...	10·5	9·0	20·3	19·5	7·2	11·8	11·6	14·5	20·0	3·6	5·0	6·0	6·0	7·0	21·0	61·1
Depth of body ...	29·0	29·5	57·5	58·3	22·5	31·5	35·0	40·0	57·5	12·2	16·5	20·5	21·0	26·0	67·0	150·0
Width of body ...	17·0	16·0	32·5	33·0	13·0	20·0	19·0	25·5	32·0	6·0	9·0	10·5	10·6	12·5	42·0	104·1
Length of dorsal spine ...	33·0	28·0	41·0	44·0	20·0	31·0	31·0	40·5	48·0	11·0	14·0	18·5	17·0	24·0	52·0	...
Length of pectoral fin ...	26·0	20·5	45·0	48·0	19·0	28·3	27·0	36·5	50·0	11·0	13·5	15·0	17·0	20·0	52·5	...
Length of pelvic fin ...	22·0	20·0	36·5	39·5	15·5	27·0	26·0	31·0	44·0	11·0	13·5	14·0	16·0	18·0	50·0	...
Length of caudal peduncle	23·0	18·5	42·5	44·0	14·3	25·5	25·5	32·0	42·0	8·0	10·0	14·0	14·0	17·0	47·5	150·0
Least height of caudal peduncle ...	16·0	13·5	24·5	25·0	10·0	14·8	16·0	19·5	26·5	5·5	6·5	9·0	9·8	11·5	33·5	61·8
Length of maxillary barbel	10·0	10·0	14·5	21·5	8·0	11·0	10·0	13·0	17·0	3·5	5·2	6·0	7·0	9·5	17·0	...
Length of rostral barbel.	8·0	8·0	14·0	17·0	7·0	9·0	9·0	13·5	17·0	3·0	5·0	5·8	6·3	8·5	16·0	...

[1] Measurements given here are of the stuffed specimen.

An asterisk (*) denotes well-developed condition of the lips, while

a dagger (†) denotes that the lips are not specially enlarged.

[12]

ACKNOWLEDGMENTS.

The cost of illustrations for this article has been borne by the Bombay Natural History Society and for this my sincerest thanks are due to the authorities of the Society. I am greatly indebted to Mr. W. K. Langdale Smith of the Rungli Rungliot Tea Estate, Darjeeling District, who very kindly afforded facilities for my artist to make a colour sketch of one of his tame Mahseers, which was caught by him from the Tista River and later kept in a kachha tank in his estate. The specimen was afterwards skinned and preserved, and is now exhibited in the Fish Gallery of the Indian Museum. The colour drawing made by the artist is reproduced here. As in the case of the previous articles Mr. K. S. Misra has helped me in the preparation of the table of measurements, and for this I am indebted to him. The colour drawing was prepared by Babu B. Bagchi, while the text-figures were executed by Babu A. K. Mondul. I am obliged to them for the skill and care with which they executed the work under my supervision.

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EXPLANATION OF PLATES.

Explanation of Plate I.

Colour sketch of a tame Putitor Mahseer, *Barbus (Tor) putitora* (Hamilton), of the Tista River. The drawing was made from a smaller specimen.

The specimen, 1,060 mm. in total length, was collected by Mr. W. K. Langdale Smith and kept in a kachha tank at the Rungli Rungliot Tea Estate, Darjeeling District. The colours shown in the drawing probably differ from those of a specimen living under natural conditions. In examples of this type of Mahseer collected from torrential rivers the paired fins are generally pale in colour (**8**).

Explanation of Plate II.

Lateral view of head and anterior part of body of 3 specimens of Putitor Mahseer from the Eastern Doons.

1. A specimen, 141 mm. in total length, from the Suswa River at Sat Narain showing plain lips. *ca* Nat. Size.
2. A specimen, 140 mm. in total length, from the Song River near Lachhiwala showing hypertrophied lips. $\times 1\ 5/16$.
3. A specimen, 108 mm. in head length, from the Song River at Lachhiwala with greatly hypertrophied lips. *ca* Nat. Size.

The lips are partially stretched outwards to show their form and extent.

(To be continued)

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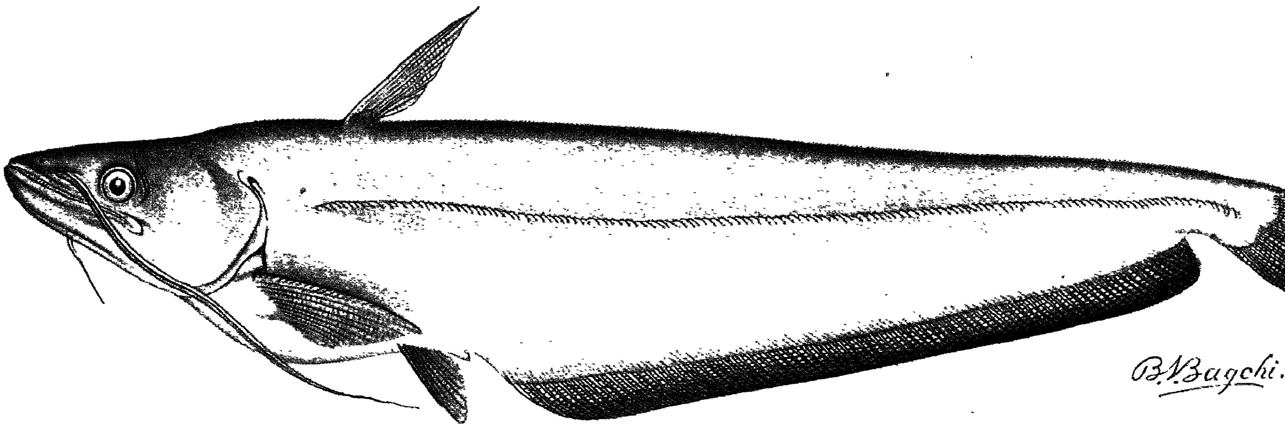
[REPRINTED FROM THE *Journal of the Bombay Natural History Society*, *Vol. XLI, No. 1, August 1939.*]

THE GAME FISHES OF INDIA. Part VII.

By SUNDER LAL HORA, D.Sc., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I.

(*With one plate and two text-figures*).



THE MULLEY or BOALI

Wallagonia attu (Bloch & Schneider).

[*From the* JOURNAL OF THE BOMBAY NATURAL HIST. SOC., *August* 1939.

THE GAME FISHES OF INDIA.[1]

BY

SUNDER LAL HORA, D.SC., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I.,

Assistant Superintendent, Zoological Survey of India, Calcutta.

(*With one plate and two text-figures*).

Continued from page 593 *of Vol.* xl.

VII.—THE MULLEY OR BOALI.

WALLAGONIA ATTU (Bloch and Schneider).

CONTENTS.

INTRODUCTION.

The most predaceous fish encountered by anglers in the tanks of India is the so-called Freshwater Shark, designated so far in scientific literature as *Wallago attu*. On account of its forbidding aspect and unclean feeding habits it is not usually eaten by the higher classes, yet there is a fair demand for it and it forms one of the important food-fishes of India. Further, in Bengal the fish is particularly valued as an offering to the goddess *Kali*. Though the *Mulley* is generally more abundant during the warm season, considerable quantities of it are offered for sale in all parts of the country at practically all times of the year. Owing to its wide distribution and familiarity it is known by an amazing variety of vernacular names in different parts of India, and very often it is puzzling, when in conversation with fishermen, to make out what kind of fish is meant.

Like other Catfishes, the *Mulley* is devoid of scales and is provided with long feelers. It is a greatly elongated fish, with the head as the broadest part. It has a huge mouth armed with two broad bands of rather large, sharp teeth. It grows to an

[1] Published with permission of the Director, Zoological Survey of India.

immense size and according to Hamilton (4)[1] sometimes specimens of six feet in length are met with. Fish weighing over 100 lbs. are not rare.

Owing to their predaceous habits, these fish are very destructive, in confined waters, to other more valuable food-fishes, such as Carp. Their presence in a tank is almost a sure indication of the absence of any other type of fish in it. As the *Mulley* can be readily fished out with rod and line it is always advantageous to clear the fishery tanks of this pest before introducing any young fry in it. Generally, they prefer muddy tanks, especially those which are subject to periodical flooding from a *nallah* or river during the rainy season. It is stated that they are far more plentiful in such tanks than in those which are fed more frequently by artificial channels.

Nomenclature and Systematic Position.

The *Mulley* was originally described as *Silurus attu* by Bloch and Schneider in their *Systema Ichthyologiae* (p. 378, pl. lxxv, 1801). In 1803, Russell (**9**) gave an account of the fish under its vernacular name *Wallagoo*, but regarded it as a *Silurus*. In describing *Silurus boalis* Hamilton (**4**) recognised its close affinity to the *Wallagoo* of Russell, but pointed out a few minor differences in the number of fin-rays, etc. The fish was described under different names by later ichthyologists (*vide* Synonymy on p. 66), but in 1862 Bleeker (**2**) referred it to his genus *Wallago* and revived its original specific name *attu* given by Bloch and Schneider. Ever since it has been known, both popularly and in scientific literature, as *Wallago attu*. In 1936, however, it was pointed out by me (**5**) that in accordance with the strict application of the International Rules of Zoological Nomenclature *Wallago* should be used for those species which are at present included under *Belodontichthys* Bleeker and a new name proposed for *Silurus attu* and its allies. However, in view of the great familiarity of the generic name *Wallago* in its present-day accepted sense I did not make any change in nomenclature. Myers (**7**) independently found the impropriety of using *Wallago* for *Silurus attu* and proposed for it the genus *Wallagonia*, with *Wallago leerii* Bleeker as the genotype. He included three species in his new genus, viz., *Wallagonia attu* (Bloch and Schneider), *W. miostoma* (Vaillant) and *W. leerii* (Bleeker). In view of these recent nomenclatorial changes the *Mulley* should be known now as *Wallagonia attu* (Bl. & Schn.).

Wallagonia Myers is included in the family Siluridae (Order: Siluroidea), which is characterised by the possession of a very short, spineless dorsal (at times it may be rudimentary or absent altogether), a very long anal and one or two pairs of barbels.

Regan (**8**) observed that 'This family has usually been united with the Schilbeidae, but the two have little in common beyond

[1] Numerals in thick type within brackets refer to the serial numbers of the various publications listed in the 'List of References' at the end of the paper

the elongation of the anal fin. The many-rayed pelvic fins, the contiguous or confluent anal and caudal, combined with the absence of a dorsal spine, of an adipose fin, and of nasal barbels, characterize the Siluridae externally, whilst the osteology is quite different from the Schilbeidae, with their rod-like palatine, frontals with free edges, and lateral ethmoids not projecting outwards.'

Among the Siluridae, *Wallagonia* is characterized by the possession of a short dorsal fin of about 5 rays, by the deeply forked caudal fin, which is free from the anal fin, by the free orbital margins to the eyes and by the position of the eyes above the level of the corners of the mouth.

Synonymy and Description.

Wallagonia attu (Bloch and Schneider).

1801. *Silurus attu*, Bloch and Schneider, *Syst. Ichth.*, p. 378, pl. lxxv.
1803. *Silurus* (vern. name *Wallagoo*), Russell, *Fish. Vizag.*, ii, p. 50, pl. clxv.
1822. *Silurus boalis*, Hamilton, *Fish. Ganges*, pp. 154, 375, pl. xxix, fig. 49
1839. *Silurus Wallagoo*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, xiv, p. 354.
1839. *Silurus asotus*, Cuvier and Valenciennes (*nec* Linnaeus), *ibid*, p. 358.
1839. *Callichrus macrostomus*, Swainson, *Nat. Hist. Fish.*, etc., ii, p. 306.
1841. *Schilbe boalis*, Sykes, *Trans. Zool. Soc. London*, ii, p. 368, pl. lxiv, fig. 3.
1846. *Silurus Mulleri*, Bleeker, *Nat. Geneesk. Arch. Ned. Ind.*, iii, p. 289.
1847. *Silurus Mulleri*, Bleeker, *Verh. Bat. Gen.*, xxi, p. 56.
1849. *Silurus boalis*, Jerdon, *Madras Journ. Litt. Sci.*, p. 335.
1849. *Silurus wallagoo*, Jerdon, *ibid.*, p. 333.
1850. *Silurus Mulleri*, Bleeker, *Verh. Bat. Gen.*, xxiii, p. 10.
1852. *Wallago Mulleri*, Bleeker, *Nat. Tijdschr. Ned. Ind.*, iii,
1853. *Wallago Russellii*, Bleeker, *Verh. Bat. Gen.*, xxv, p. 108.
1858. *Wallago Russellii*, Bleeker, *Ichth. Arch. Ind. Prodr.*, i, *Siluri*, p. 261.
1858. *Wallago Russellii*, Blyth, *Journ. As. Soc. Bengal*, xxvii, p. 283.
1859. *Wallago Russellii*, Bleeker, *Nat. Tijdschr. Ned. Ind.*, xx, p. 102.
1862. *Wallago attu*, Bleeker, *Atl. Ichth.*, ii, p. 79, pl. lxxxvi, fig. 1.
1864. *Wallago attu*, Günther, *Cat. Fish. Brit. Mus.*, v, p. 36.
1877. *Wallago attu*, Day, *Fish. India*, p. 479, pl. cxi, fig. 4.
1889. *Wallago attu*, Day, *Faun. Brit. Ind. Fish.*, i, p. 126, fig. 54.
1890. *Wallago attu*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2), ix, p. 199.
1913. *Wallago attu*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, ii, p. 201.
1916. *Wallago attu*, Raj, *Rec. Ind. Mus.*, xii, p. 263.
1923. *Wallago attu*, Hora, *Journ. Nat. Soc. Siam* (2), vi, p. 165.
1929. *Wallago attu*, Prashad and Mukerji, *Rec. Ind. Mus.*, xxxi, p. 175.
1932. *Wallago attu*, Deraniyagala, *Ceylon Journ. Sci.* (B), xvi, p. 275, pl. lv.
1934. *Wallago attu*, Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, lxxxvi, p. 87.

Vernacular names :—*Boyali* and *Keyali* (Dinajpur); *Boali* (Rungpur); *Boyari* (Bhagalpur and Patna); *Barhari* (Gorakhpur); *Shivada, Pari, Purram* and *Worshoorah* (Mahratta); *Valai, Alhi Valai, Wallah* and *Tele* (Tamil); *Boallee* (Hind.); *Ballia* and *Boalee* (Uriya); *Mulley* (Punjab); *Poikee Mulla, Pi-i-kee* and *Jer-i-kee* (Sind); *Walagah* (Telugu): *Maha Valeya* and *Valeya* (Sinhalese); *Sareng* (Manipur, Assam); *Poli* (Chittagong); *Nga-bat* (Burma); *Gwalli, Bawali, Latchi, Laki* and *Bawani* of Trihut; *Lanch* and *Lanchi* of Deoli, *Baralie* of Assamese; *Painda* of Rohtak.

Sanskrit names :—*Sahasradanshtra, Pathina Rupyabarna, Udaradirgha* and *Mahasira.*

B.18-21; D.5; A. 86-93; P.1/13-15; V. 10; C. 17.

The large head is the most conspicuous part of the fish; it increases in size considerably during the growth of the fish and its length is contained from 4.2 to 4.7 times in the standard length. The depth of the body is contained from 5 to 7 times in the standard length. The eyes are small and are situated entirely above the mouth opening; the hinder border of the eye is about one diameter in front of the posterior extremity of the cleft of the mouth. The diameter of the eye is contained from 6.5 to 10 times in the length of the head. The snout is spatulate and somewhat produced. The lower jaw is slightly longer. The maxillary barbels are twice as long as head, and extend to the anterior part of anal; the mandibular barbels are as long as snout. There are broad bands of depressible, pointed teeth in the jaws; those of the posterior rows increasing in size. The vomerine teeth are similar and are situated in two oval patches. The lateral line is well marked. There are 21 short gill-rakers.

The dorsal fin is short, spineless and is situated in the anterior third of the body length; its height is more than the postorbital part of the head. The anal is separated from the caudal. The pectorals are about two-thirds the length of the head; the spine is entire and feeble with the stiff portion as long as the postorbital part of the head. The caudal fin is forked and the lobes are rounded. The colour is more or less uniform, somewhat darker above and lighter below. The fins are sometimes covered with fine dots.

Hamilton (4) described the colouration as follows:—

> 'Above it is of an olive *shade* with a golden gloss, and below white with clouded spots, consisting of numerous black dots; but the vent and tail fins are blackish, and over the whole fish is spread a livid hue, which rapidly increases after it is taken out of the water, and soon covers the whole.'

In a fresh specimen from a Calcutta market purchased in May 1938 the dorsal surface was found to be light elm green, while the sides were of a cream colour, lighter below and darker above. Along the lateral line there was a faint band of light orange yellow. The operculum was light purple, while there was a patch of light blue behind the eyes. Along the dorsal margin of the eyes there was a band of burnt sienna colour. Above the pectorals there were patches of light indigo which faded upwards into whitish areas. Along the base of the anal fin the colour was light vermilion. The barbels were light yellowish white. The paired fins were of a light yellowish vermilion colour, while the anal and the caudal were of reddish neutral tint. The dorsal fin was marked with a yellowish neutral tint.

The air-bladder is heart-shaped and is attached to the bodies of the second to the fourth vertebrae.

Distribution:—*Wallagonia attu* is found throughout India, Ceylon, Burma, Siam, Java, Sumatra and Western Yunnan. This is the only species of the genus found in Indian waters. In the material examined it has not been possible to differentiate local races or varieties, but as a rule in the Burmese and Siamese specimens the eyes are proportionately smaller.

Measurements in millimetres.

	Bangkok, Siam	Burma	Myitkyina Dist., Burma	Rajmahal Hills, Bengal	Calcutta	Motihari, Bihar	Barabanki U.P.	Deoli, C.P.	Gonda C.P.	Travancore
Total length excluding caudal ...	445·0	171·0	360·0	101·5	445·0	190·0	251·5	180·0	296·5	383·0
Length of head	98·0	39·0	82·0	24·0	92·5	42·7	55·0	40·0	62·0	80·5
Width of head	56·5	14·0	49·0	12·5	45·5	24·0	33·0	20·0	30·0	48·0
Width of body	45·5	12·0	37·0	10·0	44·0	16·5	25·0	14·0	24·5	47·5
Depth of body	70·0	24·5	65·0	16·5	76·5	29·0	41·0	29·0	45·0	70 0
Diameter of eye	13·0	6·5	11·0	4·0	13·0	7·0	8·0	7·0	10·5	11·5
Interorbital width	42·5	13·0	35·0	8·0	37·5	16·0	22·0	14·0	21·5	34·0
Length of snout	42·0	14·5	33·0	9 0	38·5	16·0	22·0	14·0	25·0	31·5
Length of dorsal fin	57·0	19·0	53·0	14·0	59·0	25·0	31 0	20·5	38·5	Damaged
Length of pectoral fin	59·0	19·0	52·0	13·0	61·5	27·0	32·0	25·0	41·0	56·3
Length of maxillary barbel ...	192·0	80·0	161·0	37·0	184·5	72·0	100·0	87·0	47·0	117·5
Length of mandibular	24·0	12·0	27·0	8·0	32·5	Damaged	19·0	15·5	18 0	23·5

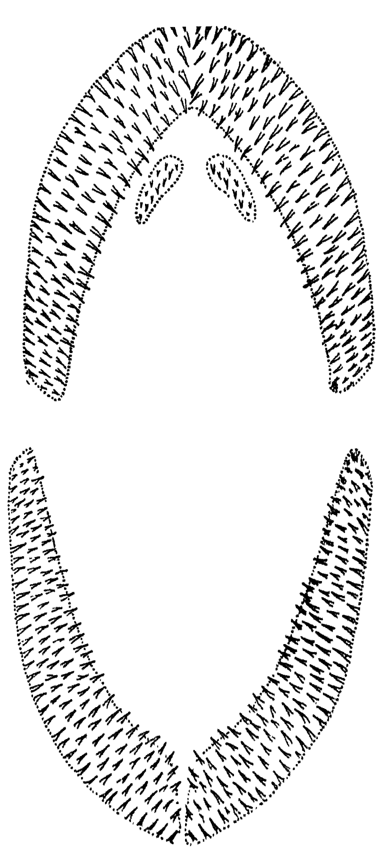
BIONOMICS AND FISHING NOTES.

In the introduction reference has been made to the general habits of the species and the types of localities inhabited by it. Sundara Raj (**10**) noted that

'*W. attu* is a large and powerful fish and predaceous in habits. It feeds on both vegetable and animal matter, preferably on the latter, and is said to destroy fry and large numbers of smaller fish in ponds. It is sluggish in its movements and lives for the most part at the bottom. Thomas attributes the frequent slowness of this fish to discover the presence of food to deficient sight. The statement that it feeds mostly at night appears to be incorrect, as I have seen it active and freely take a bait by day. It is usually caught in large nets and when handled it makes fierce attempts to bite.'

Its formidable rows of teeth (text-fig. 1), all of which are directed backwards, are not meant for mastication or for tearing the prey, but to prevent its escape once it is inside the mouth. The teeth are so effective that Thomas (**11**) warns anglers not to thrust their fingers inside the mouth to take out the hook. He observes that

'However dead the fish may seem, never dream of attempting to take out your hooks without securing yourself against his closing his awful jaws on you, by firmly wedging his mouth open with a log, or stone, or gag. And a disgorger will be found useful.'



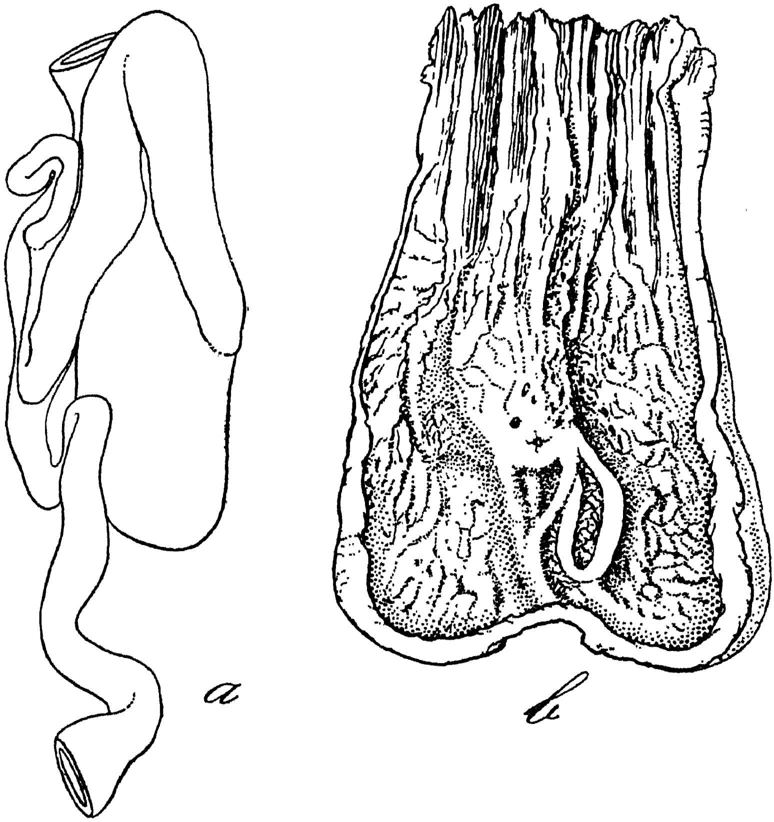
Text-fig. 1.—Upper and lower dentition of a specimen of *Wallagonia attu* (Bl. and Schn.), 302 mm. in standard length. × 1½.

The predaceous habit of the fish is also evident from the nature of its alimentary canal (text-fig. 2*a*) which is only slightly convoluted. The stomach is a large, bag-shaped structure the walls of which are greatly folded internally (text-fig. 2*b*).

These structures indicate that the fish feeds mostly on animal matter and on living organisms. There seems hardly any doubt that during its search for prey the sense of sight plays very little part and that its tactile feelers are the main agency for the fish to feel its way in the muddy waters in which it lives.

According to Beavan (**1**), *W. attu* is 'a remarkably good fish for eating purposes, when taken from clean waters, and is much

in request among the natives. In Sylhet they capture it by spearing from a boat rowing slowly up stream and coming behind the fish. This would seem to indicate that it is not a bottom feeder like many of the Siluridae.' Beavan's inference that the fish is not



Text-fig. 2.—Alimentary canal of *Wallagonia attu* (Bl. and Schn.).
a. Alimentary canal of a specimen 302 mm. in standard length. $\times 1\frac{1}{2}$; *b*. Stomach of a specimen 464 mm. in standard length cut open to show the structure of its inner walls. $\times 1\frac{1}{2}$.

a bottom feeder will be contested by all anglers. For instance Dhu (3) gives the following method of catching it :—

'A stout hand line with a dead fish on the hook, weighted and thrown into the tank bed in the evening, is sure to take in one of these monsters who will give plenty of sport. Young fish from 5 to 15 lbs. can be taken at any time of the day with a stout pike or Salmon rod and light tackle spinning with a small fish or a $1\frac{1}{2}$ inch spoon.'

Thomas (**11**) also suggests 'pike or Salmon rod, and spinning with a small fish the size of your forefinger, or even with a small $1\frac{1}{2}$ inch spoon. With such light tackle they give excellent sport.' He advocates the use of wire in preference to gimp or gut while fishing for this species,

According to Dhu, the *Mulley* 'Takes fly, spoon and spinning bait sometimes in rivers, also occasionally rises to fly in tanks, greedy as regards live bait. Fights fairly well and is not bad eating. Takes worms and occasionally paste in tanks. Also frequently springs out of water when hooked.'

Lacey (6) gives a good account of the species from an angler's point of view and suggests that best fishing can be had in warm season and on warm days.

ACKNOWLEDGMENTS.

The Bombay Natural History Society very kindly made a grant towards the cost of the illustrations, and for this I offer my sincere thanks to the authorities of the Society. Mr. K. S. Misra helped me with the preparation of the table of measurements, and for this I am indebted to him. The illustrations were prepared by Babu B. Bagchi with his usual skill and care under my supervision.

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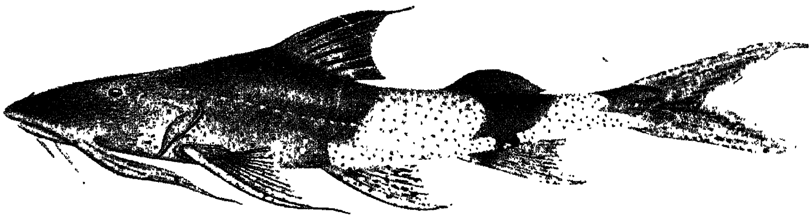
EXPLANATION OF PLATE.

Colour sketch of the lateral view of a specimen of *Wallagonia attu* (Bl. and Schn.), 464 mm. in standard length. It was purchased from a Calcutta market in fresh condition.

[Reprinted from the *Journal of the Bombay Natural History Society*, *Vol. XL, No. 4, May* 1939.]

THE GAME FISHES OF INDIA, Part VI. *THE GOONCH, BAGARIUS BAGARIUS* (HAMILTON). By Sunder Lal Hora, D.Sc., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I. (*With one coloured plate and two text-figures*).



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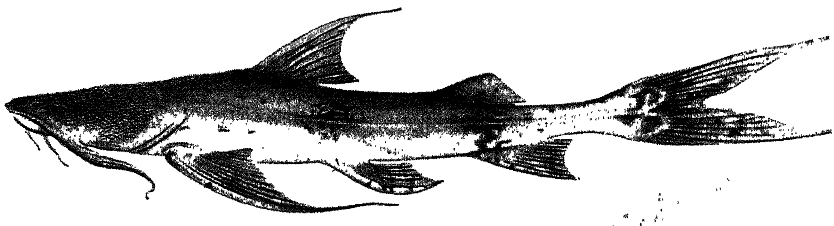

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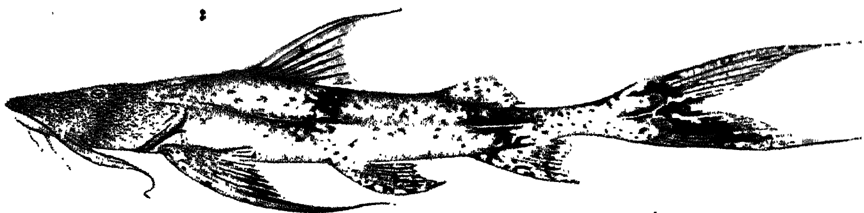

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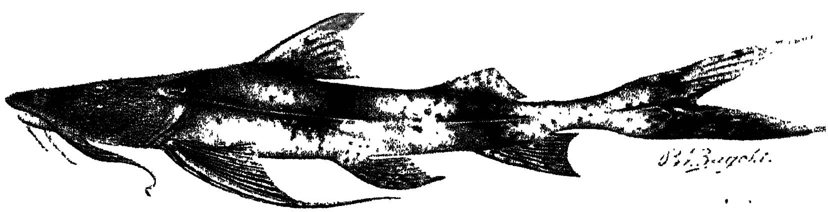

4.

THE GOONCH

Bagarius bagarius (Hamilton).

[From the JOURNAL OF THE BOMBAY NATURAL HIST. SOC., May 1939.]

THE GAME FISHES OF INDIA[1]

BY

SUNDER LAL HORA, D.SC., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I.,

Assistant Superintendent, Zoological Survey of India, Calcutta.

(*With one plate and two text-figures*).

Continued from page 366 *of Vol.* xl.

VI.—THE GOONCH.

BAGARIUS BAGARIUS (Hamilton).

CONTENTS.

INTRODUCTION.

The *Goonch* is well known, as an undesirable species, to anglers who fish for *Mahseer* in the large rivers of India. It lives in *Mahseer* waters, and must be cleared out of such areas as it is otherwise likely to break the tackle. The *Goonch* is one of the largest freshwater fish that has hitherto been caught in this country on rod and line. The smaller specimens generally give fairly good sport, but the monsters of the Ganges apparently give but little play. The name 'freshwater shark' is more aptly applied to the *Goonch*, not only on account of its great voracity but also owing to its underhung mouth and general ugliness; it grows to a size of six feet or more and to a weight of over 250 lbs.

[1] Published with permission of the Director, Zoological Survey of India.

The *Goonch*, *Bagarius bagarius* (Hamilton), is remarkable among the present-day Catfishes for its morphological features and great antiquity. Though several other genera are usually grouped with it in the family Bagaridae or Sisoridae, none approaches it in size. Most of them are of small size and live in clear waters of hill-streams adhering to rocks and stones. *Bagarius* is, however, known to descend to the lower reaches of the larger rivers as well. Fossil remains of the *Goonch* are known from the Tertiary deposits of the highlands of Padang in Sumatra and the Siwalik rocks of India. These records are not only helpful in indicating the first appearance of Catfishes (Siluroidea) but also show that the *Goonch* was as widely distributed in south-eastern Asia about five million years ago as it is at the present day. Further, it is remarkable that the *Goonch* has persisted throughout this long period without any appreciable change in its general appearance, and may thus be regarded as a 'Living Fossil'.

NOMENCLATURE AND SYSTEMATIC POSITION.

Like the freshwater sharks dealt with in the two preceding articles of this series, the *Goonch* was also described for the first time by Hamilton (7)[1] in his composite genus *Pimelodus* and characterised as

> 'A *Pimelodus* with the tail fin divided into two very long-pointed unequal lobes; with eight tendrils not longer than the head; with a scabrous opaque body, variegated with black irregular marks; with thirteen rays in the fin behind the vent; and with eight in the foremost fin of the back.'

Swainson (**11**) included it in his genus *Pachypterus* along with a number of divergent forms and re-christened it *P. luridus*. Cuvier and Valenciennes (**5**), and in his earlier works Bleeker (**2**, **3**) also, subscribed to Hamilton's views regarding the systematic position of the *Goonch*, but in 1853 Bleeker (**4**) proposed the generic name *Bagarius* for its reception and termed it '*Bagarius Buchanani*'. But as Sykes (**12**) had already described the *Goonch* from Poona under the specific denomination '*Bagrus Yarrelli*', the fish came to be known in scientific literature as *Bagarius yarrellii*. However, in accordance with the provisions of the International Rules of Zoological Nomenclature it is not permissible to change the specific name of the species except under very special circumstances. The correct scientific designation of the species should, therefore, be *Bagarius bagarius* (Hamilton), and it is under this title that the fish is generally referred to in modern literature.

Though Popta (**9**) described another species of *Bagarius*—*B. nieuwenhuisii*—from Central Borneo, Weber and de Beaufort (**14**) have shown it to be merely a colour variety of the *Goonch*. From the colour plate reproduced here and text-fig. 1 it will be seen that the fish is very variable both as regards its colour and form. In view of the above the genus *Bagarius* is monotypic so far.

[1] Numerals in thick type within brackets refer to the serial number of the various publications listed in the bibliography at the end of the paper.

As indicated above the *Goonch* is included along with several other hill-stream genera in the family Bagaridae or Sisoridae. In these fishes the dorsal fin is short, with a pungent spine and 6 or 7 divided rays, and is situated considerably in advance of the ventral fins. The adipose fin is present and is placed opposite to the anal fin. The paired fins are horizontal; the pectorals are provided with a serrated spine and the ventrals contain only 6 rays. The body is usually flattened dorso-ventrally and the eyes are subcutaneous. The two nostrils on each side are situated close together, being separated by a membranous fold produced into a short nasal barbel. The mouth is usually overhung by the snout and is either transverse or crescentic. The jaws are provided with small teeth in bands; these are sometimes mixed up with larger teeth. The palate is edentulous. There are eight barbels; one pair nasal, one pair maxillary and two pairs mandibular. The maxillary barbles possess broad and stiff bases. According to Regan (**10**), the genus *Bagarius* is distinguished from the other members of the family by a combination of the following characters:—

'Anterior precaudal vertebrae with a series of processes on each side directed upwards and outwards from the bases of the neural arches; head depressed.

'Lips normal; mesopterygoid large, extending forward below the palatine and backwards to the hyomandibular; complex centrum rigidly united, but not ankylosed to cranium; parapophysis of fourth vertebra a half-cylinder, of fifth a stout horizontal process ending just beneath the skin.

'Ribs inserted on normal transverse processes; pelvics behind the dorsal; gill-membranes free or narrowly attached to isthmus.

'Thorax without longitudinal plaits.'

The other two allied genera of the family are *Glytothorax* Blyth and *Pseudecheneis* Blyth; the former possesses longitudinal and the latter transverse adhesive plaits in the thoracic region. In its general appearance the *Goonch* is so characteristic that it is impossible to mistake it for any other fish.

The fishes of the family Bagaridae were probably evolved from some generalised members of the large group of Bagrid fishes, from which they differ in certain features of specialisation likely to have been induced by life in rapid-running waters.

Synonymy and Description.

Bagarius bagarius (Hamilton).

1822. *Pimelodus bagarius*, Hamilton, *Fish. Ganges*, pp. 186, 378, pl. vii, fig. 62.
1839. *Pachypterus luridus*, Swainson, *Nat. Hist. Fish.*, etc., ii, p. 306.
1840. *Pimelodus bagarius*, Cuvier and Valenciennes, *Hist. Nat. Poiss.*, p. 146, pl. ccccxxxiii.
1841. *Bagrus Yarrelli*, Sykes, *Trans. Zool. Soc. London*, ii, p. 370.
1847. *Pimelodus bagarius*, Bleeker, *Verh. Bat. Gen.*, xxi, I, p. 10.
1849. *Pimelodus yarrellii*, Jerdon, *Madras Journ. Litt. and Sci.*, xv, p. 141.
1850. *Pimelodus bagarius*, Bleeker, *Verh. Bat. Gen.*, xxiii, p. 10.
1853. *Bagarius Buchanani*, Bleeker, *Verh. Bat. Gen.*, xxv, p. 121.
1858. *Bagarius Buchanani*, Bleeker, *Ichth. Arch. Ind. Prodr.*, I Siluri, p. 212.
1862. *Bagarius Buchanani*, Bleeker, *Atl. Ichth.*, ii, p. 61.
1864. *Bagarius yarrellii*, Günther, *Cat. Fish. Brit. Mus.*, v, p. 183.
1877. *Bagarius yarrellii*, Day, *Fish. India*, p. 495, pl. cxv, fig. 3.
1877. *Bagarius yarrellii*, Beavan, *Freshw. Fish. Ind.*, p. 145.

1889. *Bagarius yarrellii*, Day, *Faun. Brit. Ind., Fish.*, i, p. 194, fig. 71.
1890. *Bagarius Yarrellii*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, (2), ix, p. 243.
1904. *Bagarius Nieuwenhuisii*, Popta, *Notes Leyden Mus.*, xxiv, p. 190.
1906. *Bagarius Nieuwenhuisii*, Popta, *Notes Leyden Mus.*, xxvii, p. 66.
1912. *Bagarius bagarius*, Weber and de Beaufort, in Maass 'Durch Zentral-Sumatra', ii, Fische, p. 16.
1913. *Bagarius bagarius*, Weber and de Beaufort, *Fish. Indo-Austral Archipel.*, ii, p. 270, fig. 105.
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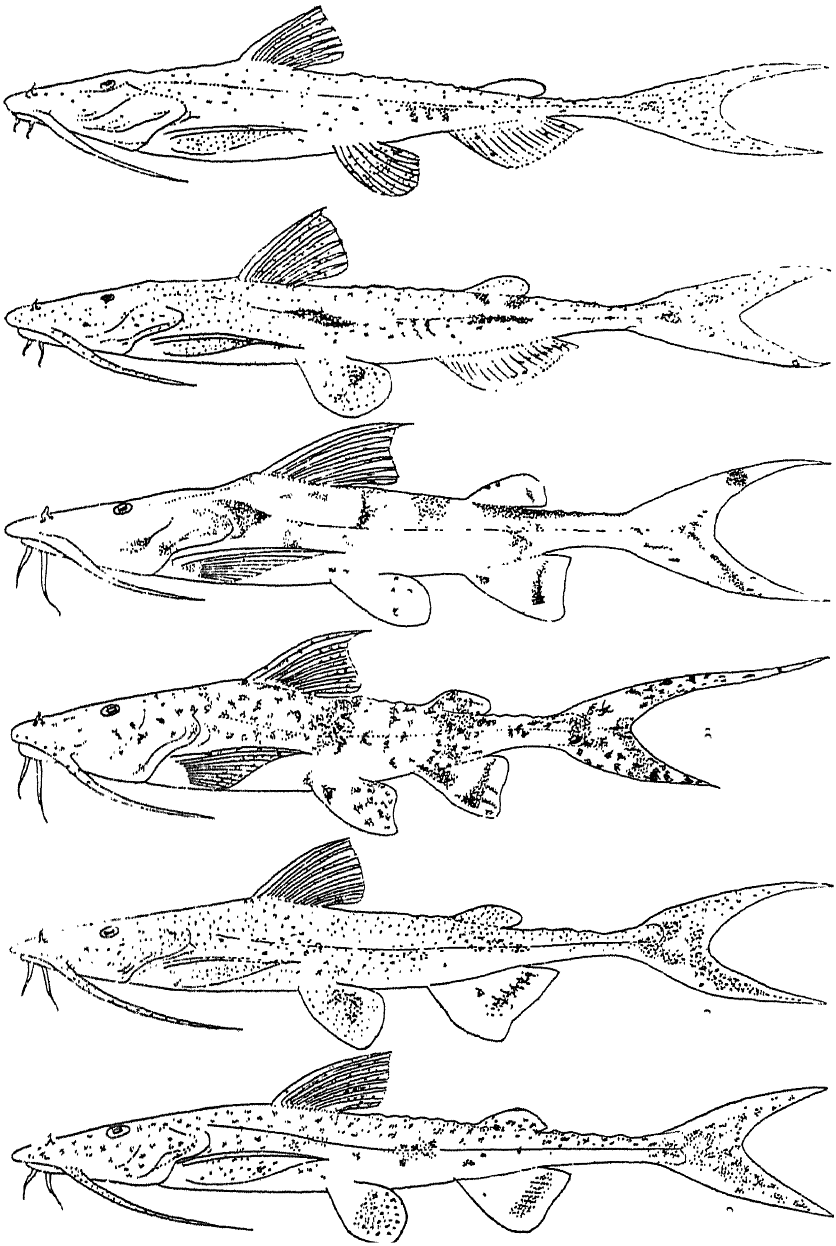
1933. *Bagarius yarrellii*, Spence and Prater, *Journ. Bombay Nat. Hist. Soc.*, xxxvi, p. 59, pl. xv.
1937. *Bagarius bagarius*, Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, lxxxix, p. 144, fig. 38-43.

Vernacular names:—*Bágh Ari* (Dinajpur and Rungpur); *Vághúir* (Purniah); *Boonch* or *Goonch* (N. W. Provinces); *Goreah* or *Bagh Machh* (Assam); *Rahti jellah* (Telugu); *Sah-lun* (Ooriah); *Kheerd, Moolandah* and *Guwch* (Poona and environs).

B 12; D. 1/6 | 0; A. 12-15; P. 13; V. 6; C. 17.

In *Bagarius bagarius* the head, the upper surface of which is naked, osseous and rugose in regular bands and lines, is greatly depressed. In consequence, the head and the anterior part of the body are flattened on the ventral surface. The skin on the body is also somewhat scabrous. The length of the head is contained from 2.9 to 3.3 times in the standard length; in medium sized specimens the height of head is contained from 1.6 to 2.0 times and its width from 1.2 to 1.3 times in the length of the head; but in a young specimen from Orissa the proportions are quite different as the head is relatively less broad but at the same time considerably depressed. In this young specimen the body is also greatly depressed, its height being contained 7.9 times in the standard length. Usually the height of the body is contained from 4.8 to 6.0 times in the length of the body. The width of the body is either equal to or greater than its height. The caudal peduncle is narrow and whip-like; its least height is contained from 3.1 to 3.8 times in its length. The eyes are small, dorsally placed and situated in the posterior half of the head. The mouth is situated on the ventral surface considerably behind the tip of the snout; the extent of its gape is equal to 4/7 of the length of the head. The teeth are sharp and of unequal size in the jaws. There is an outer widely separated row of larger ones in the mandibles. There are eight barbels; the nasal barbels are generally smaller than the diameter of the eye; the maxillary barbels possess broad bases and are generally shorter than the head; the two mandibular pairs are also very short.

The dorsal fin is considerably in advance of the ventrals; its spine is smooth, with an elongated soft termination of varying length; the osseous portion of the spine is almost as long as the head without the snout. The pectoral spine is stronger, as long as or slightly longer than the dorsal, serrated internally and provided with a soft prolongation. The caudal fin is deeply forked, the upper lobe is longer and both the lobes are produced into soft filamentous processes.



Text-fig. 1.—*Bagarius bagarius* (Hamilton), showing variation in form and colouration. (After Fowler, **6**.)

The air-bladder is small and is divided into two lateral chambers, which are situated one on each side in a deep groove formed in the consolidated transverse processes of the compound vertebra.

The *Goonch* is variable as regards its form and colouration, and as it grows to a very large size the body proportions are found to vary considerably with the size of the fish. The colouration of the species will also depend on the type of water inhabited by a particular specimen. Hamilton (7) noted that 'The *colour* is greenish ash, very pale below; and not only on the body, but on the fins, are scattered large irregularly shaped black marks. The eyes are golden-coloured'. In the case of specimens from Poona Sykes (12) found the 'Colour of the fish deep olive-brown, towards the belly yellowish brown, and marked with spots like a Dalmatian dog.' A nearly uniformly coloured variety of *Bagarius bagarius* was described by Popta (9) as *B. nieuwenhuisii.*

In the colour plate accompanying this paper, figure 1 represents the colouration of a Burmese specimen obtained by Mr. J. A. Burnes from the Nam Lon Stream, near Takaw, in the Southern Shan States on the 21st of July, 1934. Mr. Burnes sent a colour sketch of the specimen along with a description of its colouration. His description of the colouration is as follows:—

'Multicoloured fish, yellow black, brown and blue.

'Two blue streaks on head between eyes. One blue streak on back in front of anterior dorsal fin. Anterior dorsal fin: orange below and bluish with black spots above. Posterior dorsal fin: blue with black spots. Pectoral fins: reddish at roots with black spots throughout, tips yellow. Ventral fins: orange ground with black spots. Caudal and anal fins: same as ventrals. Anterior half of body: brown ground with black and yellow spots. Middle part of body: yellow ground with black spots. Part of body about the posterior dorsal fin: grey ground with black spots. Part of body behind the posterior dorsal fin: yellow ground with black spots.'

The outline of other figures on the colour plate are of a specimen from North Assam, but the colouration in the three figures represents variations exhibited by specimens taken near Calcutta. Figure 2 shows the colouration of a specimen obtained from the Settling Tanks of the Calcutta Corporation Water-works at Pulta. When just taken out of water the head was greenish grey while the dorsal surface was of a dark-greyish olive-green colour. The rayed dorsal was brownish pink anteriorly and light grey with black spots posteriorly. Behind the first dorsal and below the second dorsal there were two irregular, vertical black markings. The caudal peduncle was pink above and slightly yellow with pale grey below. The caudal was light yellowish grey. The anterior rays of the paired fins were yellowish while their remaining portions were light grey with black spots. The anal fin was light green anteriorly and light grey, with black spots, posteriorly. The ventral surface was light yellow with pale grey. An hour or so after its removal from water the colour changed to what is represented in figure 3. Figure 4 represents the colouration of a dead specimen caught in one of the canals in the neighbourhood of Calcutta and presented to the Zoological Survey of India.

Distribution:—*Bagarius bagarius* is known from all over India, Burma, Siam, Malay Archipelago and Tonkin.

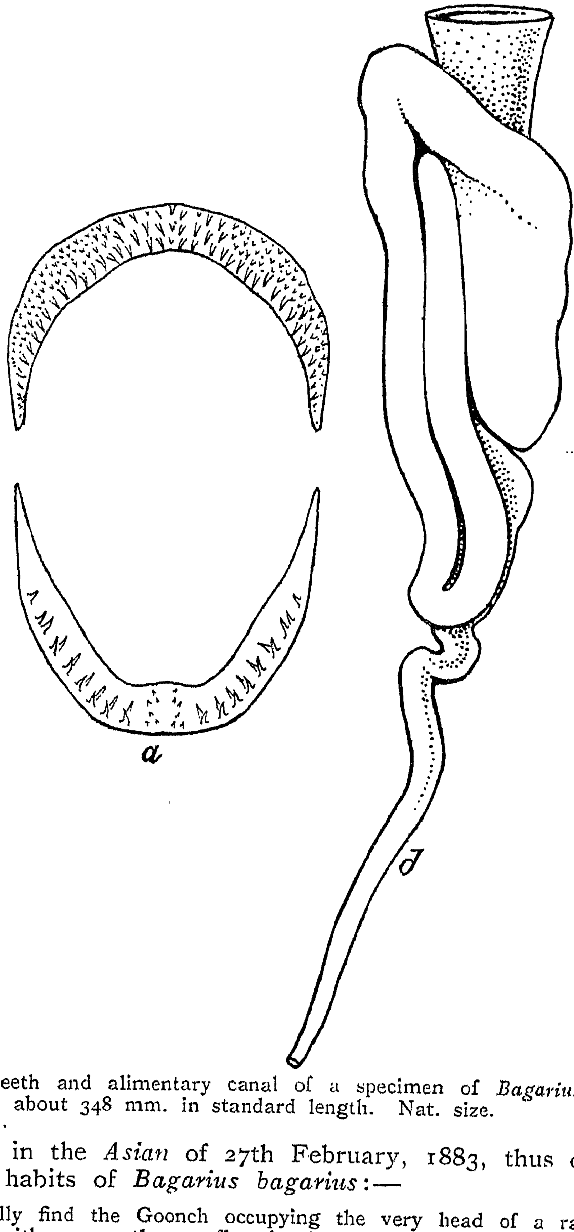
Measurements in millimetres.

	Orissa	Poona	Assam		Burma		
			Cachar	Merghe-rita	Myitkyina Dist.	S. Shan States	
Standard length	67·5	292·5	260·5	313·0	207·0	230·0	277·0
Length of head	23·0	90·0	81·5	98·5	65·1	72·0	84·0
Width of head	14·0	65·5	64·0	73·5	48·1	53·0	70·5
Height of head	9·0	54·5	43·5	49·5	33·0	37·5	49·5
Diameter of eye	3·0	8·0	8·0	8·0	6·5	6·5	7·5
Length of snout	10·0	43·0	39·5	48·0	32·0	37·0	44·0
Interorbital distance	6·0	28·5	24·5	28·5	18·0	19·5	23·5
Height of body	8·5	60·0	48·0	52·0	35·0	40·5	49·0
Width of body	8·5	56·5	50·5	52·0	37·0	40·5	55·0
Length of pectoral spine	12·0	44·0	46·0	55·0	Damaged	47·5	47·0
Length of dorsal spine	11·0	42·5	43·0	53·0	Damaged	47·0	Damaged
Length of nasal barbel	Not visible	6·0	3·0	6·0	2·0	1·5	3·0
Length of maxillary barbel	22·0	78·0	54·0	75·0	48·5	70·0	78·0
Length of outer mandibular barbel	6 0	27·0	17·5	29·5	20·0	24·0	25·0
Length of inner mandibular barbel	5·0	18·0	13·3	19·0	12·5	16·0	18·0
Length of caudal peduncle	13·5	47·0	41·0	47·0	34·0	46·0	52·0
Least height of caudal peduncle	3·5	13·0	13·1	14·0	9·5	12·5	14·0

[7]

BIONOMICS AND FISHING NOTES.

Reference has been made in the introduction to the voracity of the *Goonch*. Its formidable teeth (text-fig. 2*a*), bag-like, thick-walled stomach and only slightly convoluted alimentary canal (text-fig. 2*b*) fully testify to this habit.



Text-fig. 2.—Teeth and alimentary canal of a specimen of *Bagarius bagarius* (Hamilton) about 348 mm. in standard length. Nat. size.

A writer in the *Asian* of 27th February, 1883, thus described the general habits of *Bagarius bagarius*:—

'I generally find the Goonch occupying the very head of a rapid; they lie motionless with apparently no effort in the white water among the boulders

at the foot of a smooth incline down which the water rushes with immense force through the open sluices of the weir. Some idea may be formed of the strength of the stream from the fact that the river Jumna, which is at this point about three-quarters of a mile wide, is artificially narrowed by a bund to a width of about thirty yards, this being the length of the weir through which nearly the whole volume of water has to pass when the sluices heading the Agra Canal just above the weir are closed. The monster weighing 136 lbs. caught by Mr. Van Cortland was, I believe, caught in the white water of the rapid, or just below it in the full strength of the stream, and I have frequently seen a Goonch take my spoon or minnow here as soon as it touched the water.

'They lie very often with their backs just out of water and are easily shot with a bullet.'

'Doon' in the *Asian* of 28th October, 1879, describes the spearing of the *Goonch* in the Ganges between Bijnore and Meerut. It is stated that

'When the bridge is "up", in the cold weather under the oldest boats, the "gonch" may be seen clinging on by feelers to the bottom. It struck me they could be speared, so a friend and myself sent down our canoes, armed ourselves with barbed spears, made so that the heads should *slip off* the handles, and drove down to the Ghat. The spear heads had about 20 yards of stout cotton string attached, and to the end of the rope an inflated (bullock's) bladder. When we saw the gonch, the spear was sent "home", and the shaft withdrawn. The fish at once went off, and the bladder keeping on the surface showed his course. We followed in canoes, and taking extra spears, gained the bladder and pulled up our prey, finishing him as best as we could. One morning my friend and myself killed three gonch thus, all but 80 lbs. If this sport can be got at one bridge, I see no reason why not at every one on the Ganges and Jumna, and other streams too, for gonch abounds down country, but I must say I have never tried it anywhere else but at that one bridge.'

In the cold season the *Goonch* probably hibernates as there are few records of the fish being caught at this time of the year. It takes spoon and spinning bait, and also live bait when big. On being hooked, it generally sulks, but the young provide fairly good sport.

For anglers a good account of the species is given by Thomas (13) in his *Rod in India* from which a few extracts are given below.

Once Mr. Cyril Kirkpatrick and Mr. Aldwell wanted to clear the *Goonch* out and for this purpose 'they used the strongest tackle, a male bamboo or ringol, on which they played them till they sulked, and then they simply hauled them out, hand over hand, on a cord as thick as a pencil.'

'Mr. Cyril Kirkpatrick also prefers the shallow at the head of the white water for these fish, where, letting the bait down the white water, the Goonch takes it for some exhausted fish that has failed to get past the shutters and is falling back. He also has a preference for a good stout cord that you can haul on to, so as not to waste time or try tackle over their sulking.'

The tackle recommended is the same as dressed for *Mahseer* on wire gimp No. 2/0. When it is intended to haul them out hand over hand a stronger gimp should be used.

Beavan (1) quotes from an article in the *Pioneer* to the effect that the best bait for the *Goonch* is the Spiny Eel or 'Bahm' (*Mastacembelus armatus*). 'Like most Siluroids this fish will only bite from dark till about two hours after dark, when if taken his maw will invariably be found empty; and then again from dawn

till 8 o'clock. It seems to feed on the young of a species of herring,' (probably *Clupea chapra*).

In 1920, while collecting the fauna of the Manipur Valley in Assam, I was informed of a fish locally known as *Nga-len*, but I could not obtain any specimen during the period of my visit in February-March. The local name implies that the fish rarely moves but mainly lies at the bottom. The following remarkable account of the method of its capture was given to me (8).

'The Mohammedan fishermen who alone capture and eat this fish dive and search for it under water. On discovering a fish, they come out and take a rope with them and dive again to the same place. They tie the rope round the tail of the fish being always careful not to touch its belly as this immediately disturbs it. The rope is now taken on shore and two or three people drag the fish out. It is said to be the most powerful fish in the valley.'

At the time I was unable to identify the fish from the above account but from Thomas's description of the habits of the *Goonch* I am inclined to believe that the *Nga-len* of the Manipur Valley is *B. bagarius*.

ACKNOWLEDGMENTS.

As in the case of the previous articles in this series I have to express my sincere thanks to the authorities of the Bombay Natural History Society for making a grant towards the cost of the illustrations. Mr. K. S. Misra helped me with the preparation of the table of measurements, and for this I am indebted to him. The illustrations were prepared by Babu B. Bagchi with his usual skill and care under my supervision.

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Explanation of Plate.

Colour sketches of *Bagarius bagarius* (Hamilton), showing variation in colouration in different localities and after the removal of specimens from water.

Fig. 1.—Colour sketch of a fresh specimen from Southern Shan States, Burma.

Fig. 2.—Colour sketch of a fresh specimen from Calcutta Corporation Water-works at Pulta, near Calcutta.

Fig. 3.—Same as above, but after the specimen had been out of water for an hour or so.

Fig. 4.—Colour sketch of a dead specimen brought to the Indian Museum and stated to have been collected in a canal near Calcutta.

The outlines of the figs. 2—4 are of a specimen from North Assam,

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From the Journal of the Royal Asiatic Society of Bengal. Science.
Vol. XIV, No. 1, 1948.

KNOWLEDGE OF THE ANCIENT HINDUS CONCERNING FISH AND FISHERIES OF INDIA.[1]

1. REFERENCES TO FISH IN ARTHAŚĀSTRA (*ca.* 300 B.C.).

By SUNDER LAL HORA.

(*Received January 30, 1948.*)

INTRODUCTION.

Kauṭilya's [2] *Arthaśāstra* is the earliest known dated work of the ancient Hindus, having been written somewhere between 321 and 300 B.C. The work deals with the art of government, the duties of kings, ministers and officials, and the methods of diplomacy. I have consulted Shamasastry's English translation of the work (2nd Ed., Mysore, 1923) and throughout the article references will be made to the translation.

Mr. M. Venkataramayya, Epigraphical Assistant, Archaeological Survey of India, very kindly tabulated for me all references to fish in Kauṭilya's *Arthaśāstra* and I am very grateful to him for this painstaking work.

RÔLE OF FISHERIES DURING SHORTAGE OF FOOD.

In view of the present food scarcity and particularly of high quality protein food, it is of interest to note that in Book IV, Chapter III, dealing with remedies against national calamities, under Famines, Kauṭilya *inter alia* advises the king to

> 'remove himself with his subjects to seashores or to the banks of rivers or lakes. He may cause his subjects to grow grains, vegetables, roots, and fruits wherever water is available. He may, by hunting and fishing on a large scale, provide the people with wild beasts, birds, elephants, tigers or fish' (p. 254).

It is no unusual coincidence that the Bengal famine in 1943 made the Central and Provincial Governments in India realize the value of developing fisheries and the *Famine Inquiry Commission* in their *Final Report* (Delhi: 1945) laid 'strong emphasis on an increased production of fish as a very important part of the programme for improving the diet of the population'. It may be recalled that early in 1946, even Mahatma Gandhi recommended the catching of sea fish on a large scale by employing naval personnel and craft. At the same time, the Central Government seriously considered the possibilities of importing salted and smoked fish from abroad. Under the 'Grow More Food' campaign, the Central, Provincial and State Govern-

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[1] The writer is indebted to Dr. B. C. Law, M.A., B.L., Ph.D., D.Litt., F.R.A.S.B., for giving financial assistance to Sanskrit scholars for collating references to fish and fisheries in ancient Hindu literature in order to enable me to write this series of articles.
Reference is invited to the following two previous articles concerning the same subject:—

'Ancient Hindu Conception of Correlation between Form and Locomotion of Fishes', *J.A.S.B.*, Science, I, pp. 1–7 (1935).

'Sanskrit Names of Fish and Their Significance', *J.R.A.S.B.*, Science. Vol. XIV, No. 1.

[2] Kauṭilya is also known as Vishṇugupta and Chāṇakya.

ments are now paying more and more attention to the development of fisheries which had suffered great neglect in the past.

In Book XIII, Chapter V, dealing with the operation of a siege, Kauṭilya advises the reduction of the enemy before the commencement of the siege and among a large number of other measures suggests:

> 'A splinter of fire kept in the body of a dried fish may be caused to be carried off by a monkey, or a crow, or any other bird (to the thatched roofs of the houses)' (p. 468).

This is a significant passage, for it shows that the invading armies in those ancient days carried a supply of dried fish with them and, therefore, the art of processing fish must have been known to those people. A splinter of fire kept in the body of dried fish is not likely to go out since there is always a certain amount of body oil that will come out from dried fish when heated and this will keep the splinter alive. Monkeys, crows and many other birds used to be as fond of fish in those early days as they are at the present time.

FISHERY MANAGEMENT.

In the chapter dealing with 'Formation of Villages' (Book II, Chapter I, p. 51), it is stated that

> 'the king shall exercise his right of ownership (*svāmyam*) with regard to fishing, ferrying and trading in vegetables (*haritapaṇya*), in reservoirs or lakes (*sētushu*)'.

The reservoirs referred to would appear to be irrigation tanks and it is gratifying that even in those early days they were used for fish culture.

In accordance with the 'Regulation of Toll-Dues' (Book II, Chapter XXII, p. 135), imported commodities were charged one-fifth of their value as toll, but in the case of perishable articles such as flowers, fruits, vegetables (*śāka*), roots (*mūla*), seeds, dried fish and dried meat the toll was one-sixth of the value of the article. With regard to conch shells, the fixation of the amount of the toll was left to the judgement of experts.

The most significant point to be noticed here is that dried fish must have been a regular trade commodity and, therefore, methods of processing fish must have been known in those days.

Among the directions given to 'The Superintendent of Agriculture' (Book II, Chapter XXIV, p. 141), it is stated:

> 'The sprouts of seeds, when grown, are to be manured with a fresh haul of minute fishes and irrigated with the milk of *snuhi* (*Euphorbia Antiquorum*).'

It is interesting to note that small fish of little economic importance as table fish were used as manures and that the high value of fish manures was recognized by the ancient Hindus.

The Superintendent of Slaughter Houses (Book II, Chapter XXVI, pp. 147-148) is enjoined to enforce several regulations concerning fish and other animals. The following are applicable to fish:—

(i) When a person entraps, kills, or molests fish which are declared to be under State protection or which live in forests under State protection (*abhayāraṇya*), he shall be punished with the highest amercement.

(ii) When a person entraps, kills, or molests fish that do not prey upon other animals, he shall be fined 26¾ *paṇas*.

(iii) Of fish that have been captured, the Superintendent shall take one-tenth or more than one-tenth as toll.

(iv) Fish in tanks, lakes, channels and rivers shall be protected from all kinds of molestation.

(v) Fish living in forests under State protection shall, if they become of vicious nature, be entrapped and killed outside the forest preserve.

Among the instructions given to 'The Superintendent of Ships' (Book II, Chapter XXVII, pp. 152-153) are the following regarding fishermen:—

(i) Fishermen shall give one-sixth of their haul as fees for their fishing licence (*naukāhāṭakam*).

(ii) Fishermen shall be exempted from payment of fees for fording or crossing rivers at any time and place.

It will be worth while for Fishery Officers to examine the above regulations carefully and to compare them with the existing rules and regulations in their respective areas. It will be seen that the fishing fees charged by the Zemindars and other private owners of fisheries are far in excess of one-sixth of the haul. Usually it is one-half and sometimes even up to two-thirds. The fishermen are nowadays subjected to such an amount of rent or other imposts that they can just merely exist by carrying on their profession. It will be necessary to lighten their taxation burden in order to improve the social status and economic standard of fishermen.

Rendering Fishes Poisonous.

In Book XIV, Chapter I (pp. 478, 479), Kauṭilya deals with secret means to injure an enemy and suggests the following mixture and treatment for rendering fishes poisonous:—

'The mixture prepared from the flowers of *bhallātaka* (*Semecarpus Anacardium*), *yātudhāna* (?), *dhāmārgava* (*Achyranthes aspera*) and *bāṇa* (sal tree), mixed with the powder of *elā* (large cardamom), *kākshi* (red aluminous earth), *guggulu* (bdellium), and *hālāhala* (a kind of poison), together with the blood of a goat and a man, causes biting madness.

'When half a *dharaṇa* of this mixture, together with flour and oil-cakes, is thrown into water of a reservoir measuring a hundred bows in length, it vitiates the whole mass of water; all the fish swallowing or touching this mixture become poisonous; and whoever drinks or touches this water will be poisoned.'

There is a great deal of scientific knowledge in the practice mentioned above. In the first place, a distinction is made between poisoning and rendering fishes poisonous. In carrying out the above treatment, the fish do not die but their flesh becomes poisonous so that whoever eats it is poisoned.

Fishery Officers will recall some parallel cases. When carps are fed on silkworm pupae, their flesh becomes poisonous, so the practice is to condition such fishes for three or four days before sale. It is known that certain fishes become poisonous during certain periods of the year and investigations have revealed that this is due to the fact that during these periods fishes feed on certain types of poisonous algæ. It is known to fish culturists that the quality of the food determines the taste and flavour of the fish.

There are several kinds of herbs, fruits, barks of trees, etc. which are used for poisoning or stupefying fishes for their capture, particularly from rocky streams. The object of the treatment recommended by Kauṭilya is not the capture of the fish or to injure them in any way but to render their flesh poisonous so as to render them poisonous for the enemy.

One thing is clear from Kauṭilya's account that fish was cultured in reservoirs and that it used to be captured for human consumption. Further, during the movement of an army, fresh fish used to be a regular item of ration whenever available.

Miscellaneous Uses of Fish.

Fish forms one of the ingredients of two other mixtures used for doing injury to an enemy (p. 476). These are as follows:—

'The smoke caused by burning the powder of *śatakardama* (?), *uchchiṭiṅga* (crab), *karavīra* (*Nerium odorum*), *kaṭutumbi* (a kind of bitter gourd) and fish, together with the chaff of the grains of *madana* (?) and *kodrava* (*Paspalam scrobiculatum*), or with the chaff of the seeds of *hastikarṇa* (castor oil tree) and *palāsa* (*Butea frondosa*), destroys animal life as far as it is carried off by the wind.'

'The smoke caused by burning the powder of *pūtikīṭa* (a stinking insect), fish, *kaṭutumbi* (a kind of bitter gourd), the bark of *śatakardama* (?) and *indragopa* (the insect cochineal), or the powder of *pūtikīṭa*, *kshudrārāla* (the resin of the plant *Shorea robusta*) and *hēmavidāri* (?), mixed with the powder of the hoof and horn of a goat, causes blindness.'

Fish Metaphors.

Book I, Chapter XIII, p. 24.—People suffering from anarchy are likened to the proverbial tendency of a large predatory fish swallowing smaller ones (*mātsyanyāyābhibhūtaḥ prajāḥ*).

In this connection reference is invited to the Sanskrit names *Jhasha* and *Mina* for fish discussed in an earlier article. A predatory fish chases a shoal of small fishes, captures some and scatters the rest. When chasing them into shallow waters, it splashes water with its fins.

Book II, Chapter IX, p. 77.—

'Just as fish moving under water cannot possibly be found out either as drinking or not drinking water, so government servants employed in the government work cannot be found out (while) taking money (for themselves).'

Though there is a well-known saying 'to drink like a fish', scientifically Kauṭilya is right in saying that it is not possible to determine whether a fish drinks water or not as we do. His analogy of government servants taking bribes is very appropriate indeed.

General Observations.

Book I, Chapter XXI, p. 46.—Kauṭilya enjoins a king for his personal safety to 'get into such water as is free from large fishes (*matsya*) and crocodiles'. Here probably warning is given against sharks frequenting the mouths of rivers and certain catfishes.

Book III, Chapter IV, p. 194.—'It is no offence for women to fall into the company of actors, players, singers, fishermen, hunters, herdsmen, vintners, or persons of any other kind who usually travel with their women.'

Conclusion.

From the passages quoted from Kauṭilya's *Arthaśāstra*, it is evident that even in the dim past ages, fishery was a well-established industry in India and that fish was relished as an article of diet. During famines or other national calamities, greater use was made of fish to tide over food shortages. Fishermen were charged low licence fees (one-sixth of the value of the catch) for catching fish and were given concessions for fording or crossing rivers. Fish processing (dry fish and fish manures) was known in those days and fishery products were charged a low rate of toll tax. The ancient Hindus possessed a considerable general knowledge of the habits of fishes and used that knowledge to practical purposes or in using metaphors.

From the Journal of the Royal Asiatic Society of Bengal. Science.
Volume XIV, No. 1, 1948.

SANSKRIT NAMES OF FISH AND THEIR SIGNIFICANCE.*

By SUNDER LAL HORA, *D.Sc., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I., Director, Zoological Survey of India, Banaras.*

(*Received January 8, 1948.*)

It is a general impression among western writers that the civilized people of eastern Asia, the Hindus and Chinese, have contributed very little of importance to the development of biology.[1] Seal in his work entitled 'The Positive Sciences of the Ancient Hindus' (London, 1929) showed that the earlier Hindu writers, such as Charaka, Prasatapada, Suśruta, Śankara and Umasvati, had not only a fairly sound knowledge of the classification of animals but were also familiar with their anatomical details. It was indeed unfortunate that, without making a serious study of the ancient Hindu literature, Chaudhuri,[2] in his presidential address to the Section of Zoology and Ethnography of the Fifth Indian Science Congress on the 'History of Indian Ichthyology', remarked that

> 'I do not want to tell you anything today about the number of species of fish enumerated or referred in the Indian Medical work *Suśruta* or other ancient Sanskrit or Pali texts, nor will I mention those names which are inscribed in the edits of the good King Asoka, because the importance of these enumerations is purely historical and the records do not actually lead us towards the advancement of our knowledge of Indian Ichthyology.'

Prashad,[3] in his article on 'Some Pre-Linnean writers of Indian Zoology', has shown, on the authority of Seal, that even these enumerations, when properly studied, were of great significance, but it was not until Dr. Chhabra directed my attention to some passages in *Suśruta-saṃhitā* [4] that I [5] realized the profound knowledge possessed by the ancient Hindus concerning fish and fisheries of India. Hope was then expressed that my article on 'Ancient Hindu Conception of Correlation between Form and Locomotion of Fishes' will stimulate oriental scholars to collect old Sanskrit and Pali texts bearing on Indian ichthyology which, after careful analysis in the light of modern scientific knowledge, would have enabled us to confirm or controvert the views of the European writers in reference to the fish and fishery knowledge of the ancient Hindus. But I regret to say that my hope has not yet been realized.

Though, through the kindness of Dr. Chhabra, I have had a few more glimpes into the knowledge of the ancient Hindus regarding fish and fisheries of India, my appeal had little effect, for the simple reason that oriental scholars, generally ignorant of science, do not appreciate the hidden treasures that lie buried in ancient literature and Indian scientists, invariably ignorant of oriental languages, are not in a position to unearth the hidden treasure. What is needed is a team work between oriental scholars and scientists, if it is desired to utilize the knowledge of the ancient Hindus for the glory and advancement of our country. Let us hope the national government of the country will provide opportunities for such collaborative research.

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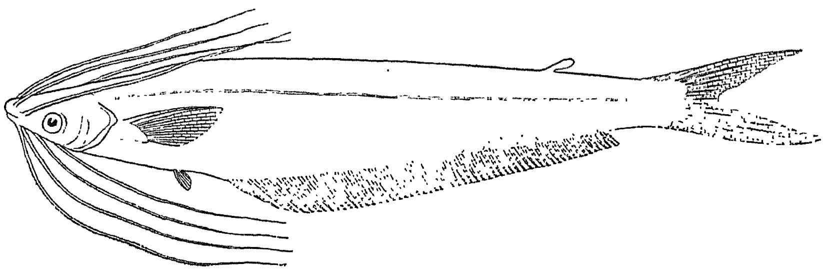
* Text of a talk given to the Epigraphical Association, Ootacamund, on Saturday, the 29th March, 1947.

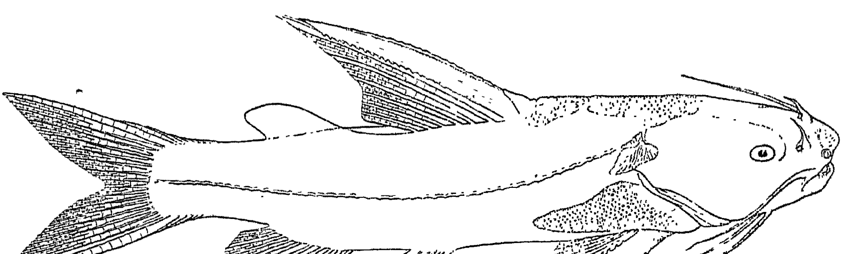
1 Nordenskiold, *The History of Biology* (London, 1929).
2 Chaudhuri, *Proc. Asiat. Soc. Bengal,* (N.S.), XIV, p. cxxxix (1918).
3 Prashad, *Acharyya Ray Commemoration Volume,* pp. 68, 69 (Calcutta, 1932).
4 *Suśrutasaṃhitā* (Sutrasthanam), Chap. 46, the Ānūpa Group 26 (*ca.* 600 B.C.).
5 Hora, *Journ. Asiat. Soc. Bengal,* Science, I, pp. 1–7 (1935).

Collaborative research envisaged by me will not only unearth ancient scientific knowledge but will enable oriental scholars to interpret correctly the meanings of some of the ancient texts and inscriptions. For instance, Dr. Chhabra has handed over to me a list of 22 words by which a fish was known to the ancient Hindus and has very kindly given me their etymological meanings. From the meanings of the words, it appears that the ancient Hindus were not only familiar with several varieties of fish but denoted it as fish by one of its characteristic features. For instance, *Matsya* (मत्स्य) or *Machchha* (मच्छ) denotes an object which intoxicates or delights, so in this fish synonym reference is made to the nutritive value



TEXT-FIG. 1.—A small Indian Cat-fish, *Ailia coila* (Ham.), showing 4 pairs of barbels round the mouth—one pair nasal, one pair maxillary and two pairs mandibular.

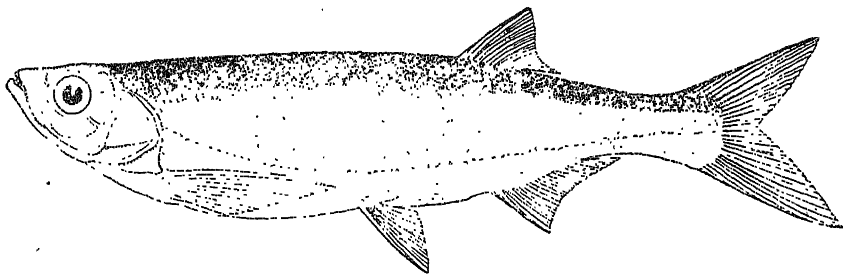
of the flesh of fishes. Reference may here be invited to such works as *Rājanighantu* (Dictionary of Medical Terms) and *Bhāvaprakāsā* (a work on Āyurvēda medicine) in which several medicinal properties are prescribed to fish flesh. It is recorded in Manu, the law giver of the Hindus, that if offerings of *Rohita* (*Labeo rohita*, the famous carp of the Indo-Gangetic plains) are given as *Saradh*, the departed ancestors remain fully satisfied for all times to come. It would thus appear that the ancient Hindus took delight in eating fish and regarded it as an invigorating food. The use of the word *Matsya* for fish in ancient Hindu literature is thus very appropriate.



TEXT-FIG. 2.—Another Cat-fish of Indian waters, *Rita rita* (Ham.), showing bony armour on certain parts of body and strong pectoral and dorsal spines, besides barbels round the mouth.

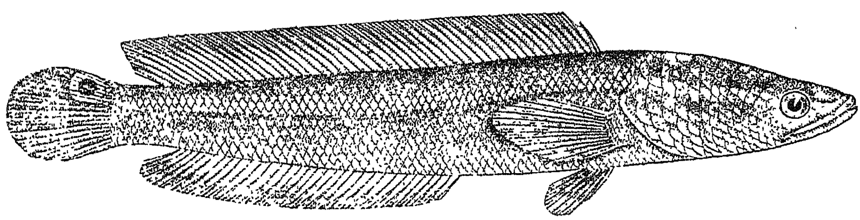
Another name for fish is *Prithuroman* (पृथुरोमन), which signifies an object with long hairs *Prithu* = big and *roman* = hair). One lexicon has 'having long hair around its snout'. Corresponding to this Sanskrit

name for fish is the English equivalent 'Cat-fish,' which also signifies whisker-like growth round the mouth. Among the freshwater fishes of the Indo-Gangetic plain, Carps (Cyprinoidea) and Cat-fishes (Siluroidea) are the two most predominant groups represented by hundreds of species. Thus it would appear that the Sanskrit name *Prithuroman* refers to one of the characteristic features of the Cat-fishes of India.



TEXT-FIG. 3.—One of the Chela fish of Indian waters, *Chela baicala* (Ham.), darker above and silvery on the sides and below.

In certain Cat-fishes, there is a bony armour covering certain parts of body which is otherwise smooth and naked. A reference to this morphological feature is indicated in the Sanskrit name *Śakalin* or *Śakulin* (शकलिन or शेकुलिन) or *Śakula* (शकुल). Practically all Cat-fishes are provided with spines in the petoral and dorsal fins and in some cases they are dentated or serrated and inflict poisonous wounds. In the *Singi* fish (*Heteropneustes fossilis*) of Bengal, the spines are so dreaded that they are broken as soon as the fish is caught. Such spines are probably referred to in the Sanskrit name *Kaṇṭakin* (कण्टकिन्). The dorsal bony spine of certain carps and Cat-fishes may be responsible for the Sanskrit name *Śuṅgin* (शुङ्गिन्) which signifies horn (*Śuṅga* = *Śṛinga* = horn).

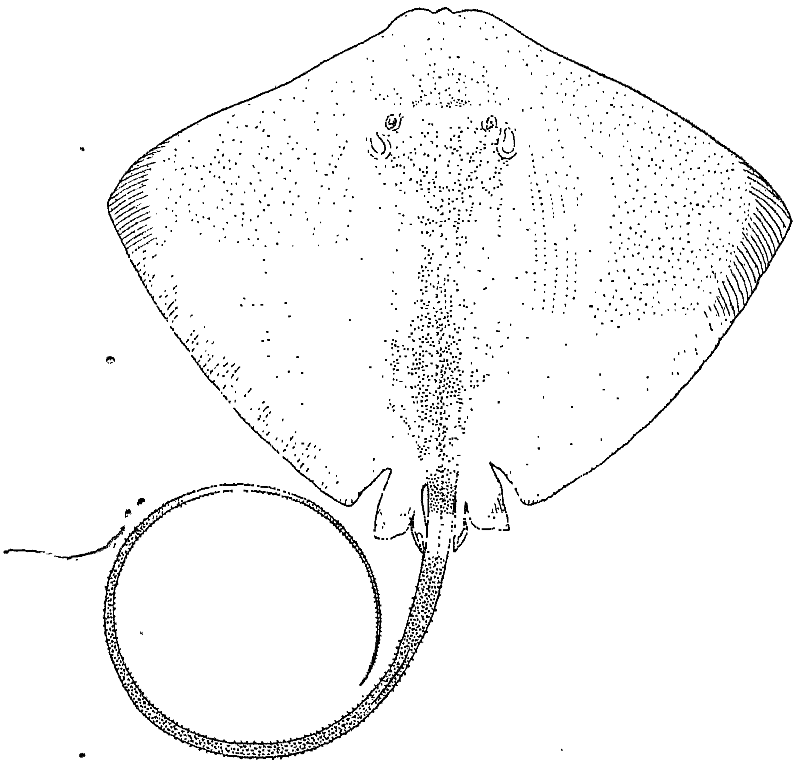


TEXT-FIG. 4.—Young of a Snake-headed fish, *Ophicephalus marulius* Ham., to show an eye-shaped spot on the caudal fin.

The Sanskrit synonyms of fish *Jhasha* and *Mīna* (मीन) signify that some fish 'kill small fish and other aquatic animals'. According to some writers *Mīna* is derived from a root which means 'scattering' or 'splashing (water)'. In both these names, reference is made to the predatory habits of Cat-fishes, Snake-headed fishes (Ophicephalidae) or Feather-backs (Notopteridae), which are widely distributed in India and feed on small fish, frogs, aquatic insects and other aquatic animals. In chasing their prey, they scatter the shoals of small fish and in their pursuit, especially into shallower waters, splash water by the movements of their fins. These

two Sanskrit names of fish thus indicate that the ancient Hindus knew the food and feeding habits of the predatory fishes of India.

Some of the predatory fishes are known to be cannibalistic in habits and aquarists are aware of the fact that in certain fishes parents must be separated from the progeny as soon as spawning is finished. In the culture of snake-headed fishes, it has been found that they devour their young ones if natural food is deficient. This habit of certain fishes is signified in the Sanskrit name *Ātmāśin* (आत्माशीन) which literary means eating itself or its own kind.

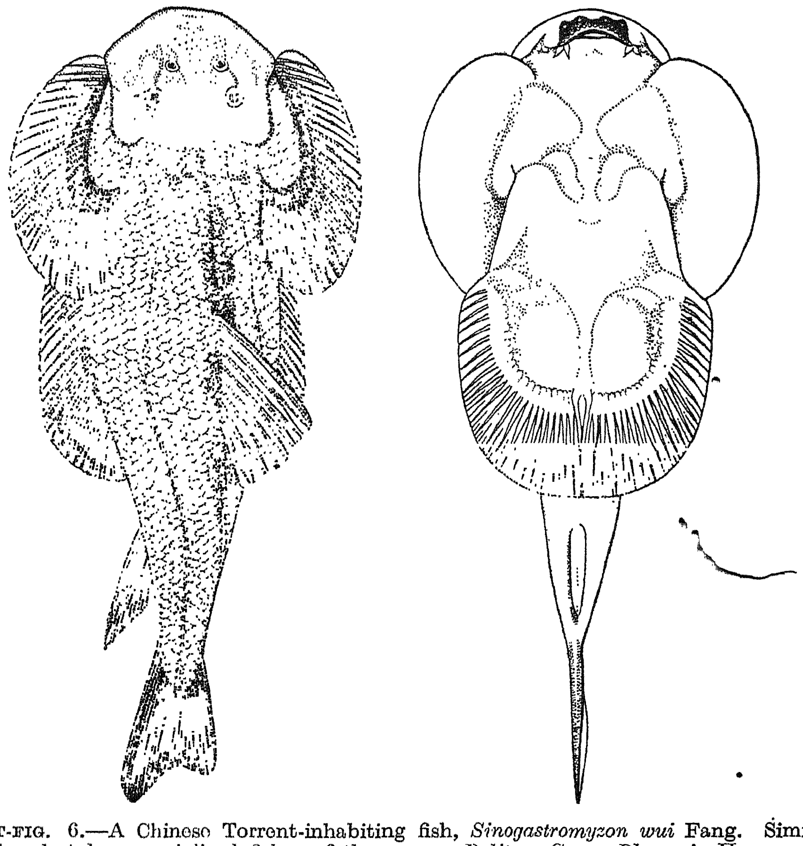


Text-fig. 5.—An Indian Ray, *Trygon marginatus* Blyth, showing the spreadout extensive pectoral fins.

Some of the Sanskrit names refer to the common characteristics of all varieties of fish, such as *Visāra* (विसार) or *Vikāra* (विकार) or *Vaisāriṇa* (वैसारिण) signifying dignified movements of fishes in various ways; *Aṇḍaja* (अण्डज) that which is born of an egg (no freshwater fish of India is viviparous though certain sharks give birth to young ones); *Mūka* (मूक) that which is dumb and speechless; *Animisha* (अनिमिष) that which does not wink its eyes and *Jaleśaya* (जलेशय) that which sleeps, stays and remains all the time in water.

It is a general characteristic of fishes that they are darker above and silvery on the sides and below. If one observes small carp minnows of the

genera *Danio, Barilius* and *Chela*, he will notice that sometimes they turn sideways and then a silvery glow is observed for a moment. I think in the Sanskrit name *Usha* (उष) for fish, a reference is made to this phenomenon. *Usha* means that which glows. In certain fishes, there are black spots on the fins with a round whitish area surrounding them thus giving the appearance of eye-shaped marks. The best known food fish with such characteristic markings is *Murral* and probably this feature is responsible for the Sanskrit name *Śandhalin* (शन्धलिन) for fish, for it signifies that



TEXT-FIG. 6.—A Chinese Torrent-inhabiting fish, *Sinogastromyzon wui* Fang. Similar, but less specialized fishes of the genera *Balitora* Gray, *Bhavania* Hora and *Travancoria* Hora are found in the hills of Assam, Darjeeling-Himalayas and Mysore and Travancore Sections of the Western Ghats.

which possesses eye-shaped marks. Of course, all fishes look pretty in a small pool or bowl of water and it is, therefore, not surprising that the ancient Hindus should have called them *Sudarśana* (सुदर्शन), meaning good-looking. The Sanskrit name *Śalkin* (शल्किन्), meaning scaly, presents no difficulty as the majority of the freshwater fishes of India are either scaly (Carps) or smooth (Cat-fishes).

The Sanskrit name *Saṁvar* (संवर) for fish is of unusual interest, for it signifies that which covers or spreads over. Such a term will apply to

skates and rays perfectly well but these are mostly marine fishes. Some rays ascend in the Ganges as high up as Patna and are a well-known feature of the fish fauna of Bengal and Bihar. Hill-stream fishes, with which the ancient Hindus were certainly familiar, have the characteristic of spreading over rocks for adhesion so as to prevent their being washed away by swift currents.

In judging the knowledge of the ancient Hindus regarding fish, it must be borne in mind that they settled and flourished in the plains of the Indus and the Ganges. The Sanskrit names discussed above generally refer to the freshwater fishes of India. A close analysis of the above data would indicate that—

(i) Fish was regarded as a delicious and invigorating food in ancient times.

(ii) Fish was defined as an oviparous, thoroughly aquatic and dumb animal which showed beautiful movements in various ways.

(iii) Fish were classified into scaly and scaleless categories.

(iv) The armour-like body plates, strong spines, barbels round the mouth, predatory and cannibalistic habits of certain Siluroids and other fishes were known to the ancient Hindus.

(v) Either the habits of rays and skates or those of the highly developed hill-stream fishes were known to the ancient people.

(vi) Besides the general beauty of fish colouration, characteristic ocellus-like markings on certain fishes had attracted the attention of the ancient Hindus.

It would appear from the above that the ancient Hindus were keen naturalists and knew a great deal about the external features and habits of a variety of freshwater fishes of the Indo-Gangetic Plain.

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BULLETIN

of the

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By

SUNDER LAL HORA

D.Sc., F.Z.S., F.R.S.E., F.N.I., F.R.A.S.B.

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BULLETIN

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DEVELOPMENT OF FISHERIES IN INDIA.

Views of Specialists.

Edited and Collated

By SUNDER LAL HORA, D.Sc., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I.,
Director, Zoological Survey of India, Benares Cantt.

CONTENTS.

FOREWORD.

Though my interest in the fish and fisheries of India was aroused as early as 1917, when as a student of the M.Sc. class at Lahore (Punjab University) I was asked by Dr. R. H. Whitehouse to make a preliminary study of the 'Fish Fauna of Lahore',[1] it was not until I joined the Zoological Survey of India in 1919 that I had an opportunity of receiving training, from the late Dr. N. Annandale, in methods of field investigation of fisheries of a given area and in studying the ecology, bionomics and systematics of different groups of fishes. My first published article on 'The Fish of Seistan'[2] was in collaboration with Annandale who, in an appendix, described the fisheries of the delta of the Helmand and the use of shaped rafts of bulrushes in India and Seistan. When entrusting me with a zoological survey of the Manipur Valley in February-March 1920, Annandale gave me a copy of his article on 'Fish and Fisheries of the Inlé Lake'[3] and wanted me to prepare a similar report with regard to the fish and fisheries of Manipur. Annandale visited the Valley for a week or so but during this brief period I learnt

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[1] The results of this study were embodied in a dissertation submitted to the Punjab University in the fulfilment of the then existing regulations for the M.Sc. degree. The dissertation not only contained descriptions of the species recorded from Greater Lahore, but an account of the methods of fishing and marketing with observations on the improvement of fisheries. A list of 42 species recorded in this work was recently published by Nazir Ahmed in his 'Fishes of Lahore' (*Bull. Dept. Zool. Punjab Univ. I*, p. 255, 1943).

[2] Annandale, N. and Hora, S. L.—*Rec. Ind. Mus.*, XVIII, pp. 151–203, pls. XV–XVII (1919).

[3] Annandale, N.—*Rec. Ind. Mus.*, XIV, pp. 33–64, pls. I–VIII (1918).

much from him which it is difficult to express in writing. The results of my survey are embodied in an account of the 'Fish and Fisheries of Manipur with some observations on those of the Naga Hills'.[1] Though later, as an Officer-in-Charge of the Cold Blooded Vertebrate Collections in the Zoological Survey of India (Indian Museum, Calcutta) I was mainly concerned with systematic work on Indian fishes, the fascinating study of Indian fisheries was never lost sight of. Several articles on the customs and habits of fishermen, methods of catching fish and on the bionomics and migrations of important food fishes were published from time to time when I was still serving in the Zoological Survey of India. From among such contributions, reference may be made to 'Mud-fishing in Lower Bengal',[2] 'Trade in Live-fish (Jiol Machh) in Calcutta',[3] 'Crab-fishing at Uttarbhag, Lower Bengal',[4] 'Wanderings of the Bombay-Duck, *Harpodon nehereus* (Ham.) in Indian Waters',[5] and a series of articles on the spawning grounds and bionomics of *Hilsa* summarized in 'Life-history and Wanderings of *Hilsa* in Bengal Waters'.[6] The series of articles on the 'Game Fishes of India' published in the Journal of the Bombay Natural History Society contains information which could be made use of by fishery scientists.

In the meetings of the Fish Committee of the Imperial (now Indian) Council of Agricultural Research, among other things, I had directed attention to the construction of dams and weirs and its effect on the fisheries of the migratory species, the pollution of streams by municipal and factory effluents and its harmful effects on natural fisheries, the preservation of fish for its proper utilization and the need for a Central Institute of Fisheries Research.

Besides contributing articles myself on Indian fisheries and raising discussions on important aspects of fisheries development from a purely scientific point of view, I requested specialists with practical experience of Indian fisheries problems to contribute notes regarding Indian fisheries. Of these, two articles by Dr. J. T. Jenkins on 'The Fisheries of India' [7] and 'The Fishrries of Bengal—Can they be improved and developed' [8] and two articles by Dr. Albert W. Herre on 'Lessons from the Fish Markets of Calcutta' [9] and 'The Fisheries Departments of the Philippines and Malay with Comments on the needs of Bengal and India' [10] are of particular interest.

Though I was thus equipped with considerable knowledge of the scientific problems of fisheries development in India, on taking over charge of the Fisheries Department in Bengal in May, 1942, I found myself lacking in essential knowledge and experience concerning the practical problems of the management and development of fisheries of diverse types and of such a highly complicated nature as those of Bengal. Fortunately for me, owing to the emergency conditions then prevailing, a considerable part of Bengal rich in fishery resources (riverine, estuarine and foreshore fisheries) had been declared as a Denial Area and the following functions were assigned to the newly created Department of Fisheries:—

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1 Hora, S. L.—*Rec. Ind. Mus.*, XXII, pp. 165–214, pls. IX–XII (1921).
2 Hora, S. L.—*Journ. As. Soc. Bengal* (N.S.) XXVIII, pp. 197–205, pls. (1932).
3 Hora, S. L.—*Journ. As. Soc. Bengal* (N.S.), XXX, pp. 1–15, pls. (1934).
4 Hora, S. L.—*Curr. Science*, III, pp. 543–546 (1935).
5 Hora, S. L.—*Journ. Bom. Nat. Hist. Soc.*, XXXVII, pp. 640–654 (1934).
6 Hora, S. L.—*Journ. Roy. As. Soc. Bengal, Science*, VI, pp. 93–112 (1941).
7 Jenkins, J. T.—*Curr. Science*, VII, pp. 43–44 (1938).
8 Jenkins, J. T.—*Curr. Science*, VI, pp. 373–375 (1938).
9 Herre, A. W.—*Curr. Science*, VI, pp. 263–266, (1938).
10 Herre, A. W.—*Sci. and Culture*, VI, pp. 629–634 (1941).

(1) To re-organize the catching and distribution of fish under emergency conditions.
(2) To conserve the present supplies, with particular reference to the fisheries of immature fish.
(3) To conduct investigations into tank fisheries with a view to increase the food supply in the province, thereby aiding the 'Grow More Food' campaign.

Starting from scratch and finding to my great regret that all earlier records of the defunct Department of Fisheries were unobtainable, I determined to educate myself in the problems of Bengal fisheries. Three courses were adopted to achieve this objective, namely, (i) personal inspection of fisheries and contacts with fishermen and fish merchants by undertaking extensive tours all over Bengal, particularly to the areas which form sources of fish supply to Calcutta; the fisheries of some other provinces were also visited; (ii) extensive study of literature and codification of the material dealing with pond fisheries, and (iii) establishing contacts with specialists in the U. K. and the U. S. A. with knowledge of Indian or tropical fishery conditions and inviting their comments and suggestions on general or specific problems.

From 26th May, 1942, to 31st March, 1943, I spent 110 days on tour; in the following year ending 31st March, 1944, 107 days were spent on tour and in the third year 104 days. With the enormous expansion of the Department in 1945, more and more time had to be spent at headquarters, but I wish to emphasize that it would have been impossible for me to appreciate Bengal's fishery problems without these tours, for 'fisheries' is a field science and not a problem for discussion in office files. As a result of these tours and enquiries a note on the 'Sources of Fish Supply to Calcutta Markets' [1] and another on 'Suggestions for the development of Salt-water Bheris or Bhasa-badha fisheries in the Sundarbans' [2] were published. The effect of the effluent from the Quinine Factory at Mungpoo, District Darjeeling, was also thoroughly investigated and suggestions made for the improvement of fisheries of the Rungbee, Riyang and Teesta rivers.[3] Much other valuable information is now available in official papers for those who may wish to make use of it.

From the study of literature on tank cultural practices in India and abroad, it seemed necessary to publish a series of short articles in *Indian Farming* [4] so as to invite suggestions and criticism from practical fish farmers. For the Imperial Council of Agricultural Research a small pamphlet entitled 'Hints on the development of natural freshwater fisheries and fish farming' was prepared. In the article on 'Fish Farms: Objectives and Requirements' [5], the methods of developing tank fisheries are elucidated. In preparing this note, I received suggestions from a large number of specialists but all this labour was undertaken in the interest of self education. Lastly, a pamphlet on the 'Culture of Katli, *Barbus* (*Lissochilus*) *hexagonolepis* McClelland, in the Darjeeling Himalayas' [6] was prepared and the need for augmenting fish supply in the hills was indicated.

[1] Hora, S. L.—*Journ. Bombay Nat. Hist. Soc.*, XLIII, pp. 665–670 (1943).
[2] The first article of the series appeared in the issue of April 1943 and since then 15 articles have already been published.
[3] Hora, S. L. and Nair, K. K.—Fishery Development Pamphlet No. 1, Government of Bengal (1944).
[4] Hora, S. L. and Nair, K. K.—*Proc. Nat. Inst. Sci. India*, X, pp. 147–166 (1944).
[5] Hora, S. L.—*Journ. Roy. As. Soc. Bengal. Science*, XI, pp. 99–117 (1946).
[6] Hora, S. L. and Ahmad, Nazir.—*Govt. of Bengal, Fishery Development Pamphlet*, No. 2, pp. 1–8 (Alipore: 1946).

Under the auspices of the National Institute of Sciences of India, symposia were organized on the 'Factors Influencing the Spawning of Indian Carps' [1], on the 'Utilisation of Sewage for Fish Culture' [2] and on the 'Development of Indian Fisheries: Objectives and Requirements'.[3] The holding of these symposia enabled fishery officers from different parts of the country to meet and exchange views on diverse subjects of mutual interest. Much valuable information was thus collected in these meetings.

Further periodic meetings of Fishery Officers of Bengal were held to which representatives of other provinces were invited for holding discussions on specific problems of mutual interest. Minutes of such meetings were published by the Directorate of Fisheries, Bengal.

In making contacts with foreign specialists, I usually sent out a note and invited suggestions and criticism. Thus on the 10th June, 1943, copies of Dr. M. R. Naidu's 'Report on a Survey of the Fisheries of Bengal' (Bengal Government Press: 1939), on the 27th October, 1944, copies of a Syllabus for a course of training in Inland Fisheries, on the 18th December, 1945, copies of a programme of work for the Inland Fisheries Research Institute and on the 22nd March, 1946, copies of a note on 'Fish Farms: Objectives and Requirements' were sent out and valuable suggestions collected. Besides several subjects were discussed at length in correspondence.

My object in writing 'Development of Fisheries in India—Views of Specialists' is to provide for others the information I so sorely needed and to obtain which so much valuable time was spent not only by myself but by those experts who so ungrudgingly gave me the benefit of their experience and knowledge.

I hope, therefore, that this Bulletin will prove of real value to all those concerned with the improvement and development of fisheries of this great country, whose fishery potentialities are enormous.

ACKNOWLEDGMENTS.

My thanks are due to a large number of fishery scientists in India and abroad, too numerous to be mentioned by names in this place, for their manifold kindnesses and courtesies, but particular mention must be made of the undermentioned whose views have provided the material for the present publication. All fishery students will join with me in mourning the great loss which our science has sustained by the premature death of Dr. Stanley W. Kemp whose foresight, great knowledge, earnestness and industry would have been of inestimable value in developing the fisheries of all parts of the British Commonwealth.

Professor L. F. de Beaufort, Director of the Zoological Museum, Amsterdam, Holland.

Captain W. R. Burgess, Late Assistant Director of Fisheries, Bengal (Marine and Estuarine), Australia.

Col. W. R. Burton, Keen Angler and Sportsman, Bangalore, India.

Mr. L. K. Elmhirst, Late Agricultural Adviser to the Government of Bengal, United Kingdom.

Dr. J. D. F. Hardenberg, Laboratorium voor het Onderzock der Zee, Batavia.

[1] *Proc. Nat. Inst. Sci. India*, **XI**, pp. 303–330 (1945).
[2] *Proc. Nat. Inst. Sci. India*, **X**, pp. 441–443 (1944).
[3] *Proc. Nat. Inst. Sci. India*, **XII**, pp. 288–290 (1946).

Dr. Albert W. Herre, Formerly Chief, Division of Fisheries, Manila, Philippine Islands. Curator of Fishes, Zoological Museum, Stanford University, California, U.S.A.
Dr. James Hornell, Retired Director of Fisheries, Madras, United Kingdom.
Dr. Stanley W. Kemp, Formerly Superintendent, Zoological Survey of India, Leader of the Discovery Expedition. Director and Secretary to Council Marine Biological Association of the United Kingdom.
Sir Pheroze M. Kharegat, Secretary to the Government of India, Department of Agriculture, New Delhi.
Major A. St. J. Macdonald, Keen Angler and Sportsman, India.
Dr. George S. Myers, Professor of Biology and Curator Zoological Collections, Stanford University, California, U.S.A.
Dr. H. Thompson, Controller of Fisheries, Australia.

VIEWS OF SPECIALISTS.

Fisheries Administration.

Stanley W. Kemp: Need for an All-India Co-ordinated Effort; Improvement of supplies through Administrative Measures; Need for an Administrative Section; Fishery Statistics; Liaison between Administrative and Research Personnel; Technological work. *R. W. Burton*: Need for propaganda. *James Hornell*: Socio-economic work; Marketing of Fish; Legislation regarding exploitation of Hilsa fisheries. *L. K. Elmhirst*: Socio-economic work. *St. A. Macdonald*: Need for Judicious exploitation of fisheries. *Albert W. Herre*: Time-scale Planning.

Stanley W. Kemp.

Need for an All-India Co-ordinated Effort.—The problems of adjacent provinces, sometimes of all India, are the same or similar, and it will often happen that two or more provinces are concerned in a particular piece of work, for fish have no respect for provincial boundaries. Thus Dr. Travis Jenkins, many years ago, tracked the spawning Hilsa up the rivers to the confine of Bengal; he telegraphed for permission to proceed into the U.P., but was refused and was thus unable to discover the location of the spawning grounds. Migratory marine fish will also present similar difficulties. The recent action of the Government of India in appointing a Fisheries Development Adviser is thus a step, though only a small one, in the right direction—one hopes it may be followed by the initiation of an all-India Fisheries Service.

Improvement of Supplies through Administrative Measures.—There is, however, one aspect which I want to stress, as giving in my opinion the best chance of an early improvement in fish supplies in Bengal, and that is the urgent need for proper administrative measures. At present the fisheries of the Province, especially of the extensive estuarine tracts of the Sunderbans, are exceedingly badly organized. There is no proper transport from the fishing centres to road or rail head, no sufficiently good arrangements for refrigeration, and in all the main towns there are rings in the fish-markets, which maintain extortionate prices while keeping the fihermen themselves at the barest level of subsistence. I believe that, in brief, to be a true picture, and that if these and similar difficulties could be overcome the amount of fish in the towns could be enormously increased.

On every hand the utmost opposition from vested interests is to be expected and a man with immense drive and armed with almost autocratic powers will be needed. A superman is required if the market rings are to be broken, and the fisherman assured a reasonable return for his labours.

Transport is perhaps a more manageable problem, for it should be possible to organize fleets of motor-boats as fish carriers on suitable routes connecting with lorry or rail transport using refrigerated containers; and though subsidies would probably be needed at first in due course transport should be able to pay its way. But in all these matters, and in arranging advances to ignorant fishermen for purchase of boats and gear, one shudders to think of the infinite possibilities for graft which are opened up.

The first point that strikes me is that immense advances in the development of the fisheries can be achieved by suitable administrative measures: piers, jetties and other facilities for landing the fish are badly needed, greatly improved arrangements are wanted for rapid despatch from the fishing grounds to centres where rail or lorry transport is available, refrigerating vans and ice supplies call for consideration and new systems of marketing must be introduced which will suppress the rings formed to keep up prices and (perhaps through the organization of co-operative societies) will ensure a reasonable profit to the actual fishermen.

Need for an Administrative Section.—All this, in my view, is purely administrative work with which you should not be expected to concern yourself very closely. Your help, as a consultant, will no doubt be continually needed, but you will have more than enough to do on the scientific side. A separate administrative section is thus clearly necessary, and I myself think that the chief of this section should have the same salary and status as yourself. You should be consulted in his selection, and it is obvious that you will need to work together very harmoniously. It is evident to me that with the enormous potential richness of the Bengal fisheries a large increase in the fish supplies to the towns could rapidly be brought about by administrative measures, provided only that the officers concerned show energy and determination in the difficult practical and social problems they may have to face.

During the past year or so I have been a member of the Colonial Fisheries Advisory Committee, and in considering the development of Colonial fisheries we have recommended (and the Secretary of State has approved) the formation of two services; a Colonial Fisheries Service, which will undertake the administrative work (collection of dues, enforcement of regulations; loans to fishermen for nets and gear, compilation of statistics and so forth) and will be responsible to the local Government, and, secondly, the Colonial Fisheries Research Service with suitable research stations responsible directly to the Secretary of State for the Colonies. In India also the same plan should be followed—an all-India Fisheries Research Service and provincial administrative departments. The administrative officers need not be trained scientifically, but they must of course work in very close touch with the research staff.

Fishery Statistics.—I would, however, add this—that it is of fundamental importance, not only for commercial purposes, but for the study of the effect of fishing operations on the stocks of fish (with a close eye on the dangers of overfishing) that quite elaborate fishery statistics should be kept, and closely studied.

It will no doubt be difficult to organize an efficient system of collection, and this will be primarily the business of the administrative staff, but it will be worth while expending a lot of energy and money on this, for adequate fishery statistics are an essential basis for fishery research work.

The primary data required for each important species are quantities caught and amount of fishing power expended—*e.g.* number and size of boats employed, number of nets, and if possible amount of time spent fishing. Information as to size-distribution of catch is also of great value;

if the fish are sorted into size-categories on the market, the quantities of each category should be recorded separately. Periodic measurements of random samples of the catches or landings are very desirable.

Liaison between Administration and Research Personnel.—When the time has come that schemes should be carried forward by the administrative officers with only occasional scientific supervision, it is the former who will undertake the necessary propaganda, the development of particular sites and the arrangements of such subsidies as may be needed. This will not mean that scientific work in connection with these projects is ended. Far from it. For it is apparent that the methods suitable in Bengal will very likely not suit other provinces. It is probable that other species will prove to be the best and it is by no means unlikely that variations in the technique will be required. Therefore, if my advice is taken on the inclusive character of the all-India research service, the Bengal fresh-water staff, with all the practical experience they have already gained, should proceed to suitable areas in other provinces and set to work to find out what modifications of technique are appropriate in the new locality. Whatever you may think of these suggestions you must admit that this is the way to utilize scientific staff, which (so far as really good men are concerned) will undoubtedly be in short supply for many years, to the best possible advantage.

Technological work.—But in one line of work administrative and scientific staffs might perhaps combine: this is in fish drying and fish preservation. This is obviously an important subject: if dried fish, prepared near the fishing grounds, can be produced in an acceptable quality some at least of the difficulties of refrigeration and transport can be overcome. Existing methods, using the sun for drying, are not well suited to the damp climate of Bengal and in this country where the subject has been closely studied (at the Torry Research Laboratory, Aberdeen) considerable progress has been made with artificial driers. An initial point to be considered is the kind of product which would be regarded as palatable in Bengal. In W. Africa experimental fishmeal plants are to be tried and it appears that a crude fish meal, made from whole fish and of strong flavour, is more acceptable to the African than a more refined product. It may be that fish-meal would not be favoured in Bengal; if so it will be unfortunate since it can be produced very cheaply. But however this may be, it is evident that experiments should be begun at once with suitable type of artificial driers for both fish and prawns, and at the same time salting and other preservation processes should be examined with a view to their improvement or extension. A start could probably be made by consulting Dr. Reay at Torry and the methods, perhaps not very up-to-date, which are followed in the Madras Presidency, should be looked into. But at the first possible moment two of your staff, preferably chemists or with good chemical knowledge, should come to Aberdeen to make a thorough study of the technique of fish processing.

R. W. Burton.

Need for propaganda.—Just as the treatment of Malaria has been brought to the notice of the people by means of broadcasts and propaganda vans, so should the necessity of conservation of fish supplies of the country be brought to the notice of the people in even the remotest hamlets; and especially will it have to be impressed on the people that it is in their own vital interests to assist in putting a stop to practices fatal to their own food supply.

Without the willing, and eager, and interested, co-operation of the people, and of all those who have control over fishing waters (contractors and others), the energies of the Institute of Fisheries will be largely abortive.

Research—Propaganda—Organization, and more propaganda for until there is willing and intelligent co-operation on part of the millions of the rural areas progress will be slow, and there will be many disappointments.

Socio-economic work.—Technical instruction, co-operative societies and savings banks should be primary objects in any Fisheries scheme of development; the same applies to the opening of new markets in large centres of population in order that the middleman may be as far as possible eliminated.

James Hornell.

Marketing of fish.—I attach the greatest possible importance to all efforts to improve the condition in which fish arrive at the market centres. Especially do the men need to be taught how beneficial scrupulous cleanliness is to the keeping quality of fish in transit; also the preservative value of salt properly applied, protection from the sun and more than anything else, the great value of gutting and bleeding. Careful handling of the catch to avoid bruising the soft flesh should be emphasized.

Legislation regarding exploitation of Hilsa fisheries.—Many essential facts are still lacking in the knowledge of the life-history of the Hilsa; these *must* be ascertained before any legislative enactments be proposed.

Socio-economic Work.—For how many hundreds of thousands of Bengalis is fishing a means of livelihood and a way of life, and art and a craft? How often is it little more than a crude and hungry existence, an intolerable burden of oppression or a worn out tradition? Without the help of science, of research, or education, of plan, and without a sense of social purpose and responsibility, has the life of the fisherman, his wife or child any basis of assurance, any clarity of meaning or any conviction of reality? How profound is his pessimism! How depressed is his outlook! Today is there any reason why, with the help of science, business organization, intelligent self-help, and public support, he should not be proud, self-confident and an all-round intelligent citizen? None!

L. K. Elmhirst.

But to help him, must we not respect his art and his age-long tradition, his sterling qualities of courage and character. Only thus shall we win his respect and confidence. Only then will he feel that we come to him to help him increase his self-respect and not to undermine it. Only then shall we be able to equip him with keener tools with which to carry on his trade, and with a social structure and a business organization that will guarantee him not only a sure-living but a rich life and a creative leisure.

Need for judicious exploitation of Fisheries.—Surely the most important factor is to make the farmer Fish Culture minded?

It is a huge question; especially in the thickly populated parts of Bengal and Bihar, where fish diet makes up such a large portion of their food, and where most of the tanks are privately owned and a source of revenue to the Zemindar.

St. A. Macdonald.

Fishing rights are sold by auction to the highest bidder, who proceeds to denude the tank of every living thing! This takes place yearly and gives little chance of recovery to the natural stocking that takes place each Monsoon.

In large tanks and lakes, they cannot completely exhaust the stocks, as is the case in the small shallow ones.

The Monsoon streams that are a means of yearly stocking of fish, fare no less favourable, as 'Baris' or Bamboo wiers are put across at intervals throughout its length, and everything an inch or more is trapped in closely meshed cage baskets. These are erected both when the fish are running up into Jheels, lakes, etc., and again when the breeding urge takes and the

fish try and move down into the larger rivers. These migrations are called in Bihar and the Eastern U.P. 'Biswar' and 'Ahwar'.

To try and convince people hard put for food, to return all small fish, would be a huge task, and nothing short of Government legislation would meet the case. The above note refers to naturally fed tanks which get their water supply from floods during the Monsoons.

Time-scale Planning.—A ten year plan for the development of Bengal fisheries be drawn up at once, if it has not already been done. Supplementing this, a twenty-five year plan should be outlined; this had best be divided into five year sections. Such a plan will give definite objectives, and will likewise serve to show the quality and number of scientific men, technical assistants, departmental heads and other staff members needed.

Albert W. Herre.

Training of Personnel for Fisheries Service.

Stanley W. Kemp: Paucity of men and ineffectiveness of isolated efforts; Advanced Training in Fisheries; Foreign Training in the U.K. *George S. Myers*: Lesson from Brazil; Limitations of Foreign Experts; Foreign Training.

Paucity of men and ineffectiveness of isolated efforts.—A major obstacle has always been that fisheries is a transferred subject. Some provinces have from time to time had one man on fisheries work, most have had none; Madras always the most progressive since the days of J. Hornell, has two or three. In these conditions satisfactory work seems to me to be largely impossible. Nothing much can be expected from a single man isolated in a particular province.

Stanley W. Kemp.

Advanced Training in Fisheries.—The real difficulty is in finding competent people for the scientific staff and administrators who are capable of carrying out the sweeping reforms that are wanted. Some help in training scientific staff could be given in this country (U.K.). The Colonial Office will be awarding post-graduate studentships for those selected for the Colonial Fisheries Service and a special course of fishery instruction covering all branches of the subject and lasting probably for one year, is now being arranged. It will no doubt be possible for Indian fishery students to join these classes.

Foreign Training in the U.K.—My plan would be to put as many good graduates as possible through your freshwater course, set them to work in Bengal or elsewhere and, in a year or so, select the brightest of them to come to this country for our fisheries course. There is, to take only one side of the work, a lot to be learnt on how the job of obtaining the essential biological knowledge of an important fish should be tackled. Unless done in the right way a great deal of time will certainly be wasted. And even when all the basic information is at hand the methods of applying the knowledge so that the condition of the stock is fully apprehended (knowledge to be used in increasing or decreasing the rate of fishing, mesh of nets and so forth) must also be learnt. No one in India has had personal experience of these matters and if this very important work is to make progress it seems to me quite essential that your people should come over here and learn it from those who have gone through the mill and have done these things themselves. Once the methods have been assimilated and applied to some species of Indian fishes it should be possible to give instruction in India. This is only one branch of the work—there are a number of others which it would at present be very difficult to teach in India.

As soon as it is possible you should send at least one of your staff, preferably two, both of whom should have graduated in chemistry, for special training in technological methods at Aberdeen.

George S. Myers.

Lesson from Brazil.—All through the later part of my thinking, I was struck with the resemblance of Brazilian problems to those of India, and one of my chief fears has been that you might, through misunderstanding of conditions here (U.S.A.), fall into the same state of admiration of our fisheries 'progress' that others have, and believe that men connected with agencies so successful as some of ours must perforce be those on whose work to pattern your own.

Limitations of Foreign Experts.—My strong advice is this: If you ever should wish any fishery experts from outside India to come as advisers, pick with extreme care, and with the provision that the man or men spend not less than one year in India, or preferably, two. Accept as final none of an adviser's recommendations until he has been there at least six or eight months, for in a shorter period he will not have sufficient experience with conditions in India for his advice to be of the best. This is especially true of Americans, who, I regret to say, are often extremely provincial people with not much desire to look deeply into the civilizations or problems of other peoples.

Foreign Training.—What I do wish is that you could convince the Indian Government of the usefulness of sending a few of your men out of India, as fishery students, for periods of not less than two years. Less than two years is not enough, as both Dr. Walford and I have discovered in the case of students from Central and South America. And I would hope that at least the first part of their sojourn, or better, all of it, could be spent at Stanford by the few who might come to America. I do not say that we are the only persons who are good fishery biologists. That would be absurd. But only about four universities in the States (and perhaps now in the world) specialize in fishery training, and of these Stanford is the only one where there are men (Dr. Herre and myself) with long first-hand experience in tropical and Asiatic fishery problems. Besides, our Professor Rich is the world's chief investigator of the Pacific salmon, an excellent limnologist, and one of the foremost general fishery biologists in the country, while Prof. Bolin is a good oceanographer and a specialist in fish and other marine ecology. Professor Weymouth, of our Physiology Department, is a leading exponent of mathematical methods and our chief authority on the shrimp and other crustacean fisheries.

Various Types of Fisheries.

Stanley W. Kemp: Importance of fresh-water and estuarine fisheries; Inshore Fisheries; Sea Fisheries. *James Hornell*: Sea Fisheries. *H. Thompson*: Sundarbans Fisheries.

Stanley W. Kemp.

Importance of Fresh-water and Estuarine Fisheries.—Freshwater and estuarine fishes afford much the best prospects of the considerable and immediate increase in fish supplies which India so badly needs.

Inshore Fisheries.—Of the inshore marine fisheries at Cox's Bazar and elsewhere, more knowledge must be acquired before much can be done. A proper survey of these fisheries and the fishes on which they are based is the first step. It would appear that power-driven boats would be a very great advantage if there are people capable of maintaining them and it may well be that considerable improvements in nets and gear could be introduced.

Sea Fisheries.—In the sea-fisheries there is undoubtedly a very large potential supply. In the year 1908 or earlier the Government of Bengal brought over a steam-trawler, the 'Golden Crown', complete with crew. They trawled assiduously off the mouth of the Hooghli and brought in very large quantities of fish, including huge saw-fish and skates 8′ or more across. Good food, all of it, but the market ring in Calcutta asserted itself, strange fish were not looked on with favour, and no sale could be found for the bulk of the catch. It is I believe a fact that the Bengali much prefers carp and other fish which to us are disagreeably muddy in flavour.

This experiment could be tried again and if proper arrangements were made beforehand for the disposal of the catch, I see no reason why it would not be successful, and an Indian trawling industry might be started. The 'Golden Crown' files, if still available, should provide a wealth of information. But it will be difficult to get trawlers at the present time and it will of course be essential to bring them out with skipper, crew and all gear.

James Hornell.

Regarding marine fisheries, there are many more ways of effecting improvements than in the case of inland fisheries, where fish breeding as well as fish catching has to be attended to.

At sea, new methods and new types of fishing boats are urgently needed. This work can be done only if efficient teachers, professional fishermen skilled in their respective methods, be employed to introduce the new devices and teach the proper way to work them in order to obtain satisfactory results. Among these new methods I strongly advocate:—

(*a*) The introduction of the *Prawn-trawl* (either the beam or the otter type) on smooth ground where prawns abound—the species of *Penaeus* in particular; and

(*b*) The utilization of the Danish Seine in localities where fishes of demersal habit abound, *i.e.* those living on or near the bottom. This method cannot be learned from books or verbal instruction; it must be taught practically by a skilled fisherman who must be chosen most carefully.

Excellent shore seines are already in use on parts of the Indian coastline and need little improvement except that the very large ones would be greatly improved if mechanical power were introduced for the heavy work of hauling in; a handwinch would be immensely labour-saving and, when the net is of exceptional length, a motor boat should be used to shoot the net.

H. Thompson.

Sundarbans Fisheries.—The proposals put forward for exploiting the fisheries of the Sundarbans appear to me quite sound, and cover broad requirements, e.g. trial and methods of fishing, obtaining biological knowledge for conservation policy, and social measures required to ameliorate the lot of fishermen.

Mr. Rochford, our hydrologist here, has found that the river mud has a property of absorbing phosphate, thus making it available to estuarine fauna. Quite possibly the same thing happens in the Sundarbans.

Fish Culture.

General Observations, with particular reference to Carp Culture.

Stanley W. Kemp: Importance of Carp Culture to Bengal; Fry Trade Development. *A. W. Herre*: Problems of Pond Culture; Experimental Fish Farm; Construction of Fish Ponds; Fertilizing of Fish Ponds; Fish Cultural Practices in China. *James Hornell*: Experimental Culture Ponds.

Importance of Carp Culture to Bengal.—Carp Culture probably affords the best opportunities for a rapid increase in fish supplies, and it is a line of work on which Bengal should concentrate much of its attention. Very remarkable results have been obtained in recent years by the Jews in Palestine and there seems no reason why the same or similar methods should not be employed in Bengal. Something in this way is already done, but existing methods are very defective and could be vastly improved. I feel sure fish farming has a great future and that, if you can get really good energetic people to assist you, you are bound to be successful.

Stanley W. Kemp.

Fry Trade Development.—The demand for fry, large at present, may be expected to increase greatly; the fishery department itself will be unable to fill it and you will have to encourage firms or private individuals: the best arrangement would be to have a list of people whose fish-farms or fry collecting arrangements were under your constant supervision, and these would be authorized to sell fry under certificate from your department.

Problems of Pond Culture.—Real carp cultivation scarcely exists in India. The collecting of specific fry of rapidly growing vegetarian or molluscan-feeding species, the fertilization of the water, and the elimination of undesirable or highly voracious and carnivorous kinds, are lines which should be intensively pursued, so as to place the industry upon a firm basis. This is a field of great promise. It will be necessary to eliminate all murrel, cat-fishes, eels, and other carnivorous fishes from every carp pond. A more difficult task will be to keep them out.

Albert W. Herre.

The rate of growth of fresh-water fishes, and the size at which sexual maturity is reached, are both very important topics, and must be carefully investigated. Closely related species are known to differ widely in these respects in some cases, so that one may be highly profitable when cultured in ponds, the other of little worth. No doubt there is still much to be learned about many of the Indian carps in respect to their suitability for pond culture.

I found in the Philippines that it was difficult to train pond owners not to overstock their waters. Far too many fry were put in the ponds.

Chinese experience says to remove the bottom sediment annually, or at most biennially. Ponds become too foul when left uncleaned for five or ten years.

Experimental Fish Farm.—There should be an experimental farm to determine what species of Indian carps are best suited to pond culture. Closely related species may vary widely in rapidity of growth, maximum size, etc. Where these matters are not clearly and positively known, much time, effort, and pond space are wasted.

The same farm should also determine the optimum number of fish to be reared in a pond. It is not enough to rear one species in a pond. Several species may be grown in a pond without detriment, provided each kind has its own physiological niche. A vegetable feeder, a plankton feeder, one eating crustacea and worms, and a molluscan feeder, can live in the same pond. Five or six kinds of carp may live together where each has its own food supply. A good deal of experimental work has been done along these lines in China. I believe there is need for similar work in India.

Construction of Fish Ponds.—It might be well to emphasize that much soil is unsuited for pond culture—salinity, alkalinity, porosity, etc., must be considered and before starting to develop a fish pond, a technical officer should always be consulted.

Where there are several tanks in a farm, they should be contiguous so that water and fish can be run from one to another, except that there can be no reversal after reaching the lowest. The tanks of a fish farm are best handled when they are really but subdivisions of a single large tank, separated from each other by dikes.

Fertilizing of Fish Ponds.—Because of the status of cattle in India, and the use of cow dung as fuel, the fertilization of fish ponds may present some difficulties if there is a considerable increase in their acreage. At the same time, I remember the 'soupy' condition of the water of the little ponds about Palta (village ponds not the waterworks ponds) and of ponds I saw in Central Province around Bisrampur. There the water was as full of organic matter as a Chinese pond with privies along its margin.

Fish Cultural Practices in China.—Fish culture in Bengal is the most promising field for investigation. Though the pond culture of carps is more than 2,000 years old in China, it has received a fresh impetus in recent years and a great deal of experimental work was being carried on when the Japanese stopped it by war. I assume you have the reports by Mr. Lin and other Chinese investigators. I visited the ponds near Hong Kong on my last trip, and studied briefly their methods. A hint of them is given in the Journal of the Hong Kong Fisheries Research Station for September, 1940.

Chinese fish farmers have worked out, by rule of thumb, ways of keeping several kinds of carps in ponds simultaneously. By utilizing kinds whose habits do not interfere seriously, they are able to keep from 3 to 5 species together. While the ration is not adjusted with scientific accuracy, it is good enough to get remunerative practical results. Much more experimental work is needed to get the ratios more perfectly adjusted. I do not think you have any large Indian carps corresponding to the Chinese sub-family Hypophthalminae. Out of the vast number of Indian carps you will certainly be able to make a wise selection. I spent nearly two weeks at the Tapah Fisheries Station, 7½ miles from the railroad station of Tapah Road, Perak, where a young Tamil, Tagiaradjan, was raising carps and other fishes in order to determine what could be used for pond culture in augmenting the native food supply.

Experimental Culture Ponds.—I consider that the first matter requiring attention is the provision of a series of fresh-water culture ponds wherein experiments may be carried out to ascertain what species of fresh-water and estuarine fishes give the best results as regards tolerance of variations in the salinity of the water, rapidity of growth, foods most useful in promoting rapid growth and suitable as regards cost, the best ways of manuring them, and the most satisfactory method of transporting fish to market both in the living and dead condition. Various other related problems will occur to the superior officers in charge.

James Hornell.

Culture of Mullets, Betki and Cat-fishes.

James Hornell: Need for Mullet Culture; Hints on Mullet Culture. *Albert W. Herre*: Possibilities of Mullet Culture; Pond Culture of Betki; Cat-fish Culture.

Need for Mullet Culture.—Mullet culture, such as is practised at Comacchio in Italy, is most important and a very profitable branch of work, as mulletries are already in existence and only require to be improved along well-recognized lines, with means arranged for the regular supply of adequate quantities of fry

James Hornell.

of those species known to be tolerant of lowered salinity and of quick growth. Whether it is economical to add artificially prepared food to their dietary is a matter for enquiry and will depend upon what seeds and grains are locally available at a cost which will prove remunerative.

Hints on Mullet Culture.—Certain species of mullet can be acclimatized to live in fresh-water. These are the ones to select for rearing in culture ponds made by sluice-bunding some of the smaller blind khals; *bekti* should also be tried—they would probably live amicably together. As for stocking with mullet it will probably not be necessary to do anything more than open *part* of the sluice (say a door) when floods are on, provided that it be found that the mullet fry are trying to go up against the current at this time; this is their habit in other localities, e.g. Italy, where mullet farming is extensively carried on.

Possibilities of Mullet Culture.—Several mullets might be suitable for pond culture in India in brackish or fresh water, as well as salt water.

Albert W. Herre.

In the Philippines certain kinds of mullet enter rivers and lakes, where they remain until they are nearly ready to spawn, when they return to the sea. Some attain a large size in fresh water, as long as one's arm, and are delicious eating, much finer than those living in the sea. Of course, some kinds, as *M. dussumeri*, never get large, but are often very abundant in bangos (*Chanos chanos*) ponds, and make a good growth. Your invaluable Pulta experience should give you a good idea about the kinds of mullet most suitable for pond culture in Bengal. The mullet cultivated in the New Territory, Hong Kong, is *Mugil cephalus*, one of the most valuable kinds and occurring in India. It is the *Mugil oeur* of Day. In the Bangos ponds around Manila Bay several kinds of mullet occur, often in abundance, and are marketed extensively. The commonest is *Mugil dussemieri*, also an Indian species. *Mugil corsula* is very common in the Ganges delta, and its growth in the settling ponds at Pulta would indicate its desirability in either fresh or brackish water pond culture. Most kinds of mullet thrive in either fresh or salt water. All the larger kinds of mullet in Indian waters should be used in experimental studies of pond culture.

Pond Culture of Betki.—The pond culture of betki is not feasible. It is a highly carnivorous fish, and our experience with bangos (*Chanos chanos*) in ponds around Manila Bay shows that betki is destructive to all other fishes in ponds. The number of betki it is possible to grow in a pond is too limited to be commercially profitable. Only vegetarian fishes are likely to be profitable in pond culture, especially true in India where there are no large amounts of waste animal protein.

Cat-fish Culture.—Certain species of Cat-fishes are valued as food by the common people, and also breed freely in ponds. There is need for more knowledge concerning them, and also for clarification of what is already known about them.

Culture of Exotic Fishes.

James Hornell: Culture of Mirror Carp, etc.; *Albert W. Herre*: Gurami Culture; Culture of *Chanos*.

Culture of Mirror Carp, etc.—I would go further afield and introduce some of the varieties of large carp reared so extensively in Central Europe

James Hornell.

(Mirror Carp, etc.). These are very easily cultured in ponds and fetch a good price wherever there are people, who, like the Jews, like to have the killing of their animals done

after a particular ritual. They are easily transported alive and may be kept alive in a market in a tub of water, for several hours, or longer if the water be changed at intervals.

Albert W. Herre.

Gurami Culture.—Bengal is probably too far north for gurami culture, and other species of the Anabantidae. Gurami are especially valuable for fresh-water pond cultivation, and the development of gurami fish farms should be vigorously supported wherever the climate allows this savory fish to be grown successfully.

Culture of Chanos.—My own paper on *Chanos chanos*, 'Bangos Culture in the Philippines' you have, no doubt, as I sent it to you when it appeared. This paper was amplified later on by two members of my staff, Montalban and Martin, and published under the following title:—

Cultivation of Bangos in the Philippines.—It is in the *Phil. Journal of Science*, as my own paper was in Vol. 47, No. 1, January, 1932. Authors Wallace Adams, H. R. Montalban, and Claro Martin.

FISH TECHNOLOGY.

Stanley W. Kemp: Scope and Problems of Fish Technology. *P. M. Kharegat*: Need for Organized Production for Large-scale Technological Operations. *James Hornell*: Freezing; Dried Fish; Kippered Hilsa; Canning; Fish Meal, Fertilizer and Oil. *Albert W. Herre*: Need for an Experimental Fish Curing Yard; Fish Meal.

Stanley W. Kemp.

Scope and Problems of Fish Technology.—In a humid country like Bengal it must always be difficult to sun-dry fish and prawns properly and there appears to me to be no doubt that experimental work with artificial driers is called for. Canning is another process that needs consideration but as I understand that canned fish is not much appreciated in Bengal, drying will be the first thing to tackle. I see from the report that artificial driers are in use in S. India and that printed particulars of these plants are available. If I were starting on this kind of work my first step would be to obtain the pamphlets and send them to Dr. G. A. Reay, Torry Research Station, Aberdeen, for criticism of the methods employed. Dr. Reay is our leading expert on these matters and I am sure you will find him very helpful; methods are continually being improved and it may be that those now used in South India are no longer the best available.

As a beginning I imagine you will want at least two experimental driers for fish, two for prawns and one for preparing fish meal, all situated at centres where ample supplies are available. A small charge for drying should ultimately cover the costs of the work.

P. M. Kharegat.

Need for Organized Production for Large-scale Technological Operations.—It is all very well to talk about fish preservation, but why do not these technicians induce private firms to take up this work. The answer is that it does not pay as a commercial proposition. You cannot run a factory if you have an excess for 3 or 4 days and nothing for the next week. Unless production is organized to secure regular supplies in adequate quantities, factories cannot function. The first step is and must continue to be organized production, followed by refrigeration to prevent spoilage, it is only after these have been attended to that there will be any scope for canning, dehydration, etc.

James Hornell.

Freezing.—For the richer classes who can afford to pay high prices, brine freezing of the best qualities (*betki*, the Indian salmon, etc.) by a well-capitalized Freezing Company with their own retail shops in Calcutta and other populous centres, would probably find this industry profitable, provided the factory could be located

at a fishing centre where large supplies of fish could be obtained direct from the nets.

Dried Fish.—Oily fish should not be sun-dried; only 'white' fish and small fish cure well in the sun. Sanitary rules should be made and enforced to ensure hygienic methods and adequate inspection arranged; punishment for infringement is necessary. Salting in various ways requires experiment and whatever methods are found correct for specific species of fishes should then be brought to the notice of curers. In Bengal climatic conditions differ so greatly from those of Europe that the methods found correct in Europe may not accord with local Bengal conditions; the difference in regard to the species treated in the two areas further complicates the situation; practical experiments are absolutely essential.

Kippered Hilsa.—The *kippering* of Hilsa is a promising method of preparation and should be introduced as quickly as possible.

Canning.—One demonstration cannery should be built at as early a date as possible for herein lies great opportunities for expanding the consumption of fish by a method which will enable the fish treated to remain good for an indefinite period; it would also tend to create an export trade. Canning offers a great commercial opening to enterprising firms.

What I do hope to see before long is a *commercial* cannery in India producing canned fish products on a scale comparable to what the Americans do in regard to Salmon and 'Pilchards' and the Japanese did before the war in the canning of crab meat. Indian sardines are quite as good as the French product and immeasurably superior to what the Americans call 'Pilchards'. Indian prawns should be saleable much cheaper and quite equal to the American pack of prawns. Same with regard to fish oil, fish meal and fish fertilizer.

Fish meal, fertilizer and oil.—I cannot press too urgently the enormous field for development which exists in regard to these three items of work. All are of the utmost value to the community and there is a great future for them if adequate attention be devoted to their development. Small, inexpensive factories have been most successful in Madras *when sardines have been* abundant, but unfortunately this fishery is erratic and when a poor season recurs, the factories are not profitable. This seasonal disability does not exist in Bengal where there is fair regularity in the annual richness of the fisheries from which the necessary waste material is obtained. Of the three products, meal and fertilizer are the most important; oily fishes in Bengal are of less importance but this is not to say that a fish-oil industry is not to be considered seriously.

FISHING CRAFT AND GEAR.

S. W. Kemp: Introduction of new types of nets; Government Factory for manufacture of netting; Motor-boats or Outboard Motors for Fishing. *James Hornell*: Netting Machine; Steam Trawling; Local Methods. *Albert W. Herre*: Improvement of Craft and Gear. *R. W. Burton*: Preservation of nets and improvement of fishing boats. *L. F. de Beaufort, J. D. F. Hardenberg, Albert W. Herre*: European methods of fishing *versus* Japanese methods. *W. R. Burgess*: Improvement in Fishing Craft and Gear.

S. W. Kemp.

Introduction of new types of nets.—It is possible that the introduction of new types of net will sometimes prove effective, but for the present, and particularly with existing difficulties in importing gears, it appears to me best to leave the fishermen to their traditional methods. If marketing difficulties are overcome and the fishermen get a better price, supplies will increase automatically.

Government Factory for manufacture of netting.—It may well be necessary to establish a Government factory for the manufacture of netting.

Motor-boats or Outboard Motors for Fishing.—The introduction of motor-boats or outboard motors for fishing, would no doubt be an advantage but it appears to me that very great caution will be needed since most of the fishermen will have no knowledge of machinery and would not be able to look after the engine properly; but the experiment may be tried in a few places where a reliable man is available.

Netting Machine.—This should be operated by private enterprise, if possible; if no firm will take this up, then a demonstration machine might

James Hornell.

be necessary. But these machines require skilful operation and the one set up by the Madras Fisheries was never successfully used. This means that no suitable operator was on the staff. Either an Indian should receive training in England or an English workman should be engaged for a year to teach operations. It is because of this that I suggest private enterprise. Once started, the trade of machine netting should prove very remunerative.

Steam Trawling.—I do not advocate steam-trawling yet awhile. There is much that can be done at once in other ways to improve fishing methods without risking such a fiasco as has invariably followed the premature attempts hitherto made by the Government of Bengal, Bombay, Madras, Ceylon and Burma; the time is not yet ripe and will not be until the Government has improved transport by rail by which refrigerated cars with satisfactory means for the keeping of fish in good condition from the port of arrival until they reach the consuming centre, will be available to the fish trade. Till the problem of fish distribution by rail and motor lorry be solved, it seems useless to catch fish by such wholesale and efficient methods as steam trawling and Danish seining on a really big scale.

Local Method.—I have found that in the majority of instances the methods of fishing evolved locally have good reason for their continued existence, based upon long standing experience and with intimate acquaintance with the habits of the particular kind of fish concerned, habits which may be unusual and different from what is usual in other localities—differences brought about by some local peculiarities of the environment. Hence I find the local methods always well worth studying; instead of suggesting a change over to a new method which may at first sight appear likely to be more effective. I would advise that a trial should first be made to find some *simple* way of making the local method more satisfactory in catching power.

Improvement of Craft and Gear.—It will be a very difficult matter to alter these native methods, but there can be no great improvement until

Albert W. Herre.

power boats of some sort, and better styles of nets, are adopted. The Manila Bay fishermen fought the introduction of power boats, and clung tenaciously to their ancient style of fine meshed nets for many years. Finally power boats began to be accepted, and in recent years a motor-boat would tow a fleet of old style boats out to the fishing grounds, and bring them back when laden, thus enabling them to get their fish to market in far better condition than ever before. Along with the introduction of power boats must go eventually the more difficult task of bringing about the use of keel-built boats, with cargo space.

Preservation of nets and Improvement of fishing boats.—I would add introduction of better methods of preventing rot of nets and lines; and

R. W. Burton.

improvement of fishing boats on some parts of the Coast. For instance, the Ratnagiri Boats are much superior to the craft in use further south, so that the Ratnagiri fishermen

can go further out to sea and bring in catches of fish unobtainable by the men with inferior boats and equipment.

European methods of fishing versus *Japanese methods.*—Do not try European methods. The experiments made with North Sea trawler in the Java Sea have not been successful. Since the Japanese started fishery in the Indo-Australian Archipelago about twenty years ago, the fish markets in Java were overflooded with a quantity of species, which hitherto were never brought to market. Hence a study of the Japanese fishery methods ought to be made.

L. F. de Beaufort.

According to me trawl fisheries are not well possible in Indian waters, may be a very few small areas excepted. Research in the Laboratory for Investigation of the Sea at Batavia proved that the amount of living material in and on the sea bottom is only a small fraction of the amount of the same in the North Sea. As this living material can be assumed to be basis of food for the bottom fish one can safely conclude that the total amount of suitable trawl fish will be much less too than in the North Sea. Our statistical data are most probably partially or totally lost now, but the results of our research are given above. It is a great pity that it cannot be published in detail as we planned before the war.

J. D. F. Hardenberg.

In spite of all efforts, the only real advances made in fisheries throughout Indonesia up until 1940 were those introduced by Japanese fishermen. The Japanese fishermen, using sea-going motor launches, go in all sorts of weather except during an actual typhoon. From fishing grounds nearby and from those 700 miles away they brought fish in good condition to Manila. In a short time numerous Japanese outfits were at work over most of the Philippines, and also in the waters of Borneo, Malaya and throughout the Dutch East Indies.

Albert W. Herre.

Improvement of Fishing Craft and Gear.—Although Madras has developed the fisheries, the two most important aspects of fishing 'craft and equipment' have been neglected.

W. R. Burgess.

All types of craft are needed for the Madras coasts and with a population, such as the province has, trawlers are not recommended. But small craft from 25 ft. sailing and motor to 45 to 50 feet seine and ring net boats are desirable.

Regarding equipment Madras will need to blend their nets with overseas types, so that suitable equipment may be had for their particular type of fishing.

Take for instance, the Rampina net—this net shortened, lightened, balanced and crossed with a Japanese ring net, would be ideal for off-shore operation. Several variations may be made for different parts of the coasts, so that they may be suitable for sardine and mackerel fishing.

Although the Bengal craft are primitive and poor construction, they have been specialized for their individual operation. It would be a gamble to introduce power craft as an economic venture to compete against these craft. If production is to be increased in the rivers and estuaries, it would probably be better to concentrate on stepping up efficiency, transport and marketing facilities by introducing modified equipment, power-tug-*cum*-refrigerated craft and refrigerated transport.

The type of craft which operate the foreshores of Bengal is not a passage maker and is dependent on favourable weather. Much could be done to increase marine food production by introducing new types of craft and

equipment. A properly rigged shoal draft centre-board boat for foreshore work may be worked by a crew of 3 to 5 men and larger types to operate Danish seines and long lines offshore.

FISHERIES RESEARCH.

Stanley W. Kemp: Scientific knowledge essential for the proper conduct of a fishery; Fundamental Research Problems; Need for an Indian Fisheries Research Service; Fisheries Research in the British Colonies; Inland Fisheries Research; Fish Farm Experiments; Fisheries Research Stations; Research Problems of Estuarine Fisheries. *George S. Myers*: Need for systematic work. *Albert W. Herre*: Literature, Publications and Library. *R. W. Burton*: Co-ordination of Research and Extension Schemes; Fishery Catalogues.

Scientific knowledge essential for the proper conduct of a fishery.—Experience in this country (U.K.) has clearly shown that a full knowledge of the biology of fishes—of their rate of growth, length of life, age at sexual maturity, development, migration and so forth—is essential to the proper conduct of a fishery, and that in Bengal practically all this knowledge has yet to be acquired.

Stanley W. Kemp.

Fundamental Research Problems.—On the scientific side you will, first and foremost, always bear in mind the need for acquiring full information on every important species of fish. At present it is I suppose true to say that our ignorance is almost complete. In the first place, by examining very numerous samples from as many localities as possible and at different seasons by measurements and by studies of scales and otoliths, you want to ascertain essential knowledge on such matters as the rate of growth, the age at sexual maturity, spawning seasons and localities and migrations. Even when the more important information has been acquired you will need to continue the observations, firstly because such work will give early indications of whether the fishery is declining through overfishing (the consequences of which may be utterly disastrous if not detected in time) and secondly because regular and continued work will yield data on annual fluctuations which may in due time afford a basis for fishery prediction. This is essential work which cannot be hurried and which obviously cannot be expected to produce early results, but none the less, regard it as of primary importance. In it there is enough work to keep a large and well-trained staff busy for a very long term of years. As a beginning I think you should if possible start with a small number of carefully selected men working on a few of the most important species. Don't let them get distracted by trying to deal with every kind of fish that comes their way—if they do, you won't get anywhere. Much the best method, as we have found over here, is to have one man for each species—the one species is his subject and you will expect him before long to have the most expert knowledge of it, not only of its ecology, but of its distribution and density in different areas, of the ways in which it is caught and of its importance in the fisheries. Later when the fundamental work has been done and while still keeping a check on it he can tackle another species. In this way you can only deal of course at the beginning with a small number of species, but you will be continually expanding until in course of time you have a comprehensive knowledge.

Need for an Indian Fisheries Research Service.—All the fisheries research people in the country should be incorporated in an all-India research service under the Central Government, while each province should have its own fisheries administration staff. This, I feel sure, is the proper form of organization; it is similar to what we have devised for the Colonies, viz.

a research service directly responsible to the Secretary of State who will have a Fisheries Adviser and a Colonial Fisheries Advisory Committee, while each colony will have its own fisheries administrative service.

The local Governments will constantly need expert scientific advice, but this can always be given, for I assume that as soon as sufficient staff is available at least one member of the Central Research staff will be available in each province. The advantage of this centralized arrangement is that scientific staff will be used properly and will not waste their time, as I think is otherwise inevitable in dealing with administrative problems on which, indeed, they may very likely prove incompetent—for it is to be remembered that they have been selected for their scientific ability and not for administrative capacity. Moreover, local and provincial Governments are usually without any proper appreciation of the value of research. They are incapable of taking the long view, will expect practical results within a single year from any piece of research, however, recondite; and they are in general quite incompetent to control and get the best results from a scientific staff. Though I knew all this well enough before, I have recently been amazed at the extreme difficulty of getting Colonial Governments to understand the most elementary principles of scientific research.

Fishery Research in the British Colonies.—Plans for post-war fishery research both in this country and in the colonies are now being considered. A fishery service for the colonies is being established and fishery stations are contemplated in W. Africa, the West Indies and other places. It is almost certain that fishery research fellowships will be awarded to suitable graduates in science and that special courses of instruction covering all branches of fishery research will be arranged. When this scheme comes into operation you will be able to send some of your people over here to attend the classes, and I feel sure this will prove advantageous. At least one of your men should visit Palestine to look into the details of carp culture.

Inland Fishery Research.—There is, I imagine, a great deal of experimental work to be done before it can be claimed that the best methods for tank culture have been finally ascertained and it is apparent that a well-equipped station for this work, with a very large number of tanks should be started without delay. Similarly paddy-*cum*-fish schemes must be developed by trained scientific staff, though with both lines of work a time should come when the best technique has been discovered and pamphlets for the guidance of cultivators have been issued.

Fish Farm Experiments.—A great part of Bengal is ideally situated for fish farming and I have no doubt at all that by taking appropriate measures the fish supply from this source could be very greatly increased. The various races of the European carp now extensively farmed in Palestine breed very well in ponds and fry can thus easily be obtained in pure culture without the admixture of predaceous species. It might even be worth while seeing how the European carp would do in Bengal. That, however, would be for the future. Your immediate aim will be to set up a fish farm and hatchery. Here you must undertake extensive experiments on a number of different lines. Make sure that the species will not breed in still water; if this is so arrange ponds with a good inflow and outflow and see if the fish will then breed in them, at the same time starting a hatchery for artificially fertilized eggs, which may ultimately prove to be the best way. Find out all you can about the fry which are collected in the rivers and, in particular, whether it is possible to eliminate the young of predaceous fishes and retain only the fry of the species required. In your experimental ponds, which will need to be very numerous, there is much work to be done. Which species is the best, what is the optimum number

for a given volume of water, what is the best way of feeding, how often should the pond be drained and the crop taken and what weight of fish may reasonably be expected from a given area of water? In Palestine the fish are fed on cotton seed residue; this is apparently eaten directly by the fish, while any that remains uneaten goes to increase the plankton content of the water. This is a much easier business than the shallow culture ponds for Entomostraca. It will be worth while seeing if a food stuff similar to cotton seed residue can be found.

Fishery Research Stations.—I think you should aim at establishing two experimental farms for fresh-water fish in places with different conditions, two stations for estuarine fish and one similar station for inshore marine fishes. Of these five stations the fish farms with their experimental ponds, pumping plant, hatcheries and so forth will be much the most expensive. As a beginning at any rate, these stations may be quite small places—little more than offices with rooms set apart for laboratories. The estuarine and marine stations will need a motor research vessel each and those for the estuarine work at least should be sufficiently large to provide sleeping accommodation for the crew and scientific staff. I assume that the men working on Hilsa and prawns will be based on one or other of these stations and that the experimental drying plants will be erected in their vicinity.

Research Problems of Estuarine Fisheries.—On the estuarine fishes, betki, pomphret, mullet and so forth, it does not seem easy to make specific suggestion. Here again our knowledge is deficient. At least four of your staff should concentrate on these important fishes and with more information it should be possible to find ways for improving the fishery. I would not advocate hatcheries until more is known, but it might be worth while making small scale experiments in fish farming in a blind khal in the Sundarbans. Experiments in rearing flat-fish are now in progress in a Scottish loch and appear to be promising; the loch is separated from the sea by sluice gates and the water is chemically enriched. It may be that work on some such lines as these would prove successful in Bengal.

Need for systematic work.—One of the fundamental necessities of modern fishery research is the existence of reliable fishery catch statistics from different localities, and those statistics must be comparable. Lacking the systematic basis, the statistics in Brazil were in hopeless confusion, and one result of our survey will be systematic work on the marine commercial species to enable Brazil to initiate the taking of crude though comparable catch records at the main ports at least. India needs four or five good fish systematists, and I hope you can do something about it.

George S. Myers.

Literature, Publications and Library.—Literature, Library and publications are all very important. It is impossible to carry on research without a library, and equally impossible to maintain productive research without a channel for publication of results.

Albert W. Herre.

A very important corollary of the publication of a scientific journal or research bulletin is the building up of the library of the station or institute. Scientific knowledge is distributed by the world-wide exchange of publications. To buy all the journals would be very expensive and many cannot be purchased, but are only obtainable through exchange. The publication of a suitable journal would be one of the most effective means of maintaining the library in touch with the latest literature and keeping the staff posted on the latest results of experimentation and investigation, both in the field and in the laboratory. A Fisheries Research Institute worthy of the name cannot function without a journal.

Co-ordination of Research and Extension Schemes.—There would probably have to be, all along the Coast Line of India Fisheries Control Stations at selected places such as: Karachi, Surat, Bombay, Ratnagiri, Marmugoa, Karwar, Mangalore, Calicut, Cochin, Tuticorin, Negapatam, Chingleput, Nellore, Coconada, Chicacole. At these places, and perhaps others also, there would be greater or lesser Research establishments; and in this way the necessary organization would be built up as present conditions indicate and in the light of future experience and development.

R. W. Burton.

Always will it have to be borne in mind that hand in hand with research must be the practical development of the fisheries; the improvement of vessels and gear; the improvement of storage and transport arrangements to ensure the maximum results from the nets to the markets; and, betterment of wages and living conditions and general uplift of the fisher people themselves.

Fishery Catalogues.—One of the first necessities is compilation of a comprehensive and accurate list of all the local names of all the Commercial sea-fishes, also the food they prey upon. This list would be in English, with Scientific names in Latin, and vernacular names in the various languages and be completed all along the coast by Districts, or Control Stations, or as may be found best. This list would be necessary to all the Research establishments and to the contractors and headmen of fisher communities, and those in charge of curing yards and so on. It would have to be translated into the various languages in use along the whole coast line. Without such a list there would be much confusion of effort.

I think that there should, if possible, be illustrations of the commercial fishes as a guide to all who have the list in use or for reference. These could be numbered to tally with the list and be arranged on a separate sheet affixed to the list, or as found convenient.

CALCUTTA :—Published by the Royal Asiatic Society of Bengal, and Printed by Norman A. Ellis, Baptist Mission Press, 41A Lower Circular Road.